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ORIGINAL ARTICLES.

I.—Notes on new or imperfectly known Chalk Polyzoa.

By R. M. Brydone, F.G.S.

(*Continued from Vol. IX, p. 435.*)

(PLATE IV.)

Mucronella (?) Spenceri, sp. nov. Pl. IV, Figs. 1 and 2.

This species is very closely related to *Mucronella* (?) *Batheri*.[1] It is, however, generally on a much larger scale; and the single tube or paired tubes lying on or in the convex front wall are very much larger in proportion and occupy nearly the whole of the front wall, with the result that they determine the general level of the zoarium. The aperture is sunk deep below the general zoarial level at the foot of the front-wall tube or tubes, and therefore much overshadowed by them; it is semicircular, and has a small rounded tongue projecting horizontally from its lower lip. More often than not a small oœcium is present, but even that lies wholly below the general zoarial surface and makes very little show. The rule that a zoœcium which begins a new line has one front-wall tube, while a zoœcium which lies in a line already established has a pair, is less strict than in *M.* (?) *Batheri*, but is still a fairly general rule, especially in the later stages of the zoarium.

This species occurs chiefly in the zones of *Offaster pilula* and *Act. quadratus*, but occasionally in lower zones. Even when perfectly preserved it is apt to be very vague and indefinite in aspect, and it is anything but easy to recognize its structure; after specimens have suffered a little damage the deep cups in which the apertures lie take on a very considerable resemblance to the open areas of a *Membranipora*, and then its prominence to the naked eye relatively to its area is often the surest indication of its true nature. The original figure of *M.* (?) *Batheri* was inadequate, and I give a fresh figure of the type for comparison. It seems hardly possible to assign these two species satisfactorily to *Mucronella*, even if they can be brought within the formal definition of that genus; and if, as I strongly suspect, they are allied to *Cryptostoma gastroporum*, Marss.,[2] they might well be transferred to Marsson's genus. This point can hardly be determined from figures only.

[1] Geol. Mag., 1906, pp. 289 et seq.

[2] *Die Bryo. d. Weiss. Schreibkr. d. Inseln Rugen*, p. 96, taf. x, fig. 6.

HOMALOSTEGA CAVERNOSA, sp. nov. Pl. IV, Figs. 4–6.

Zoarium always free and unilaminate, thick and strong.

Zoœcia diamond-shaped and convex, the outlines marked only by hollows, no sutures being observable; apertures in depressions at the points of the diamonds and circular except for a slightly flattened lower end; in the front wall there is a shallow chamber extending from the centre of the front wall, where it communicates with the surface by a pore, to the edge of the aperture over which it opens by a horizontal tubular opening, the upper edge of which when perfectly preserved impinges slightly on the true outline of the aperture. These openings are the only indication of the existence of this chamber in a perfectly preserved specimen, but it is frequently exposed in damaged specimens by the breaking away of its roof.

Oœcia not observed.

Avicularia rare, vicarious, occurring as long narrow cavities with rounded ends; deep down in them there appears at the upper end a narrow horizontal front wall which tapers away towards the middle of the avicularium, but does not wholly disappear from sight until at a point a little below the middle of the avicularium two slender denticles spring from the edge of the avicularium at the general zoarial surface-level; these probably are the remains of a bar spanning the avicularium, of which, however, no instance has yet been observed; below these denticles the side walls of the avicularium are no longer horizontal but sloping steeply inward round the semicircular lower end.

The species occurs from time to time at Trimingham. There is a distinct suggestion of relationship between it and *Mucronella* (?) *Batheri* and *M.* (?) *Spenceri* in the front-wall chamber of the one and the front-wall tubes of the others, which is, however, much weakened by the presence of vicarious avicularia; and I have placed it under *Homalostega* so as to keep it near *H. suffulta*, Marsson,[1] which seems likely to be even more closely allied to it.

HOMALOSTEGA VULCANI, sp. nov. Pl. IV, Fig. 7.

Zoarium unilaminate, always encrusting.

Zoœcia bounded only by very faint hollows, no sutures being discernible, with slightly convex front walls and shortish heel-shaped apertures, which often have their lower lips slightly turned up; they are very freely sprinkled with small volcano-like eminences, some proportion of which are shown to be avicularian by the preservation of the mandibular cross-bar, which makes it probable that all the others are also avicularian. These eminences show a strong tendency to lie in a rough semicircle round the apertures along the hollows which indicate the zoœcial boundaries.

Oœcia not observed.

Avicularia of two sorts, (1) the accessory kind above mentioned, (2) vicarious; the latter are not infrequent, and have a strong general resemblance to those of *H. cavernosa*, but their sides are not straight but slightly bulging, and the front wall occupies all the

[1] *Die Bryo. d. Weiss. Schreibkr. d. Inseln Rugen*, p. 95, taf. x, fig. 4.

upper half of the area and then dies away very rapidly round a practically circular aperture; the lateral denticles are shown to be the remnants of a cross-bar by the preservation of such a bar in a few instances.

This species, which occurs from time to time at Trimingham, is placed under *Homalostega* on account of its general similarity to the preceding one.

EXPLANATION OF PLATE IV.

(All figures × 12 diams.)

FIG. 1. *Mucronella* (?) *Spenceri*, nov. Zone of *Offaster pilula*, West Meon, Hants.
" 2. *Mucronella* (?) *Spenceri*, nov. Zone of *Act. quadratus*, East Tytherley, Hants.
" 3. *Mucronella* (?) *Batheri*, mihi. Type-specimen. Trimingham.
" 4. *Homalostega cavernosa*, nov. Trimingham.
" 5. " " "
" 6. " " "
" 7. *Homalostega Vulcani*, nov. "

II.—The Origin of Septarian Structure.

By A. Morley Davies, A.R.C.S., D.Sc., F.G.S.

THE explanation of Septarian structure, almost universally accepted in England, is stated as follows by Sir A. Geikie: "Septarian—a structure often exhibited by concretions of limestone and clay-ironstone which in consolidating have shrunk and cracked internally" (*Text-book of Geology*, 4th ed., p. 136). "In many cases the internal, first-formed parts of a nodule have contracted more than the outer and more compact crust, and have cracked into open polygonal spaces" (ibid., p. 647).

A. H. Green similarly wrote: "Occasionally a contraction of the interior, after an outside solid crust had been formed, produced the cracks of the septaria, in which percolating water deposited a crystalline lining" (*Physical Geology*, p. 280).

J. Geikie expresses himself more cautiously, as indicated by the two words here italicized: "The cracks are widest towards the centre of a concretion, and die out towards its circumference, *as if* the interior had contracted after the outside had dried and become consolidated" (*Structural and Field Geology*, p. 119).

If we go back to De la Beche, we find him also expressing himself with great caution: ". . . the ordinary manner in which such nodules are broken in the interior, the cracks not extending to their exterior surfaces, as if there had been a shrinking of parts from the centre outwards, so that the resulting largest openings were central" (*Geological Observer*, 2nd ed., pp. 597–8).

For years I had, in teaching, adopted this explanation of septarian structure by contraction of the interior, but always with an uncomfortable feeling that I could not maintain it under cross-examination by an intelligent student. Why should the deposition of calcium or iron carbonate between the particles of an argillaceous rock cause contraction in bulk? If it did, why should that contraction be

confined to the earliest region affected and delayed until after further deposition had taken place around? These were questions to which I could not suggest an answer, but unfortunately I never had them pressed upon me until on an expedition with Mr. E. E. Lowe, B.Sc., of Leicester, the question was raised between us, and in a few minutes it flashed upon me that the real explanation must be, not contraction, but *expansion*. I have delayed publishing this opinion for over two years in the hope of getting some confirmatory evidence, but the chances of coming across such are so rare that it seems advisable to call general attention to the subject so that many observers may look out for them.

It is obviously more probable that the deposit of calcium carbonate in the interstices of a clay should result in expansion than in contraction. We may think of a concretion as formed by the addition of successive thin shells to a minute original nucleus. This nucleus may be thought of as so minute that it can expand without internal strain. When the first thin concentric shell of clay immediately around the nucleus was impregnated with calcium carbonate, it would expand and tend to separate from the nucleus; but owing to the continuity of deposition it would be too firmly welded to the nucleus to do this. It would therefore exert a tensile strain upon the latter, which would lead to the formation of radial cracks as the sectors of the nucleus were pulled away from their centre. As each successive shell was impregnated and expanded it would exert a similar strain upon the shells within it and the nucleus, so that a series of radiating cracks growing wider inwards would result. It might occasionally happen (owing perhaps to a temporary interruption to the continuous deposit of calcium carbonate) that it was easier for a newly-deposited shell to separate from the next one within than to split it radially; in that case a concentric crack would be formed which would widen later as its enclosing shell was in turn pulled outwards by the expansion of still later-formed shells.

Confirmatory evidence of this explanation is not easy to get. It might be thought that where large septaria occur, not too near together, in a well-laminated shale, the latter might be seen to be more compressed above and below the nodules than between them. But, apart from the difficulties of observation resulting from possible slipping, etc., we must bear in mind that the general compression of the shale is of later date than the formation of the septaria,[1] and it would be hopeless to discriminate between extra compression due to the passive resistance of the already-formed nodule and that due to its expansion during growth.

The only direction in which a crucial test of my explanation seems possible is that of the careful study of the relation of radial and circumferential cracks, especially in regard to width, and I would suggest to all geologists whose work lies among beds in which septaria abound, to keep a look out in this direction.

[1] This was pointed out by De la Beche (loc. cit., p. 597). Fossils which are found in a crushed state in the shale are uncrushed in the concretions. This is the case, for instance, with the Christian Malford ammonites, as Pratt long ago noticed.

It only remains to add that, since planning this paper, I have found that my explanation is not altogether original. It has substantially been given by Seeley, as follows: "As new matter is aggregated to the outside, it is soft, and consists more of clay than of carbonate of lime. Afterwards the carbonate of lime becomes infiltrated into the outer clayey layer, and enters into crystalline combination, so as to expand the outer layer more than the internal part. This splits the concretion internally but not externally, and thus, as the whole mass enlarges, the system of internal cracks also becomes better developed" (Phillips's *Manual of Geology*, pt. i, edited by H. G. Seeley, p. 103).

As this passage does not seem to have attracted attention, and the *Manual* has long been out of print, the present paper seems justifiable.

III.—Note on the Eocene Beds of Hengistbury Head.

By F. R. Cowper Reed, M.A., F.G.S.

THE succession of the Eocene beds exposed on Hengistbury Head, near Christchurch, was described in some detail by Mr. J. S. Gardner in 1879.[1] Four divisions were recognized by him, and they were termed in descending order (1) the Highcliff Sands, (2) (3) the Upper and Lower Hengistbury Head Beds, and (4) the Boscombe Sands. No list of fossils from any of these divisions appears to have been published, but on the Survey Map, Sheet 16, the following fossils are mentioned in the beds of Hengistbury Head, though no precise horizon is given:—

Cardium semigranulatum.
Cytherea obliqua.
Solen affinis.
Thracia sp.
Lamna elegans.
Otodus appendiculatus.
Leaves of Dicotyledonous plants.

Prestwich[2] mentioned a *Modiola*, and Mr. Gardner records "a few casts of bivalves" from the lower part of the Hengistbury Head Beds (without giving any generic determinations), as well as sharks' teeth from the ironstones.

During a recent brief visit to the headland a considerable number of fossils were collected by me in the clays between the two upper bands of ironstone concretions exposed in the large quarry on the Head. The upper band of ironstone concretions is here about 5–6 feet below the base of the Highcliff Sands which cap the sides of the quarry, and it was in the lower part of the 6 feet of buff or pale chocolate-coloured sandy clays which lie between this band and the second band of ironstone nodules that the fossils were found. Nearly all of them are in the state of casts and are difficult to extract whole, so that their determination is sometimes difficult or

[1] Gardner, Q.J.G.S., vol. xxxv, p. 269, 1879.
[2] Prestwich, Q.J.G.S., vol. v, p. 43, 1848.

impossible. But about the identification of the following six species there can be little doubt, and they are of importance as marking the horizon :—

Nuculana [*Leda*] *minima*.
Protocardium turgidum.
Corbula pisum.
Crassatella sulcata.
Panopea [*Glycimeris*] *intermedia*.
Calyptræa aperta.

The species about which more or less uncertainty exists or which are indeterminable are the following :—

Anomia lineata (?).
Arca duplicata (?).
Pectunculus [*Axinæa*] *dissimilis* (?).
Cardium cf. *formosum* (?).
Cyrena cf. *crassa* (?).
Meretrix [*Cytherea*] cf. *incurvata*.
Callista [*Cytherea*] (?) sp.
Cardita sulcata (?).
C. (small) sp.
Corbula ficus (?).
C. cuspidata (?).
Tellina sp.
Turritella sp.
Callianassa (?) sp.

Fragmentary plant-remains are common, and the vertebra of a small fish was also found.

The beds immediately below the second band of ironstone concretions have not so far yielded any recognizable fossils, though many fragments of plants form thin seams; but about 8–9 feet below it, that is about 20 feet below the base of the Highcliff Sands, the following two species were collected in a dark chocolate-coloured clay with grains of glauconite, and traces of other mollusca were noticed at the same time :—

Mytilus affinis.
Tornatellæa Nysti.

At the base of the cliffs at the north-east corner of the headland dark-greenish and chocolate-coloured clays are exposed at the beach level and for a few feet above it, and these are in places crowded with grains of glauconite and clear quartz. In these beds about 30 feet below the base of the Highcliff Sands the Echinoid *Schizaster D'Urbani* was found.

The interest of the above-recorded fossils lies in the indication they give of the age of the Upper Hengistbury Head Beds in which they occur. In the Geological Survey Memoir *On the Country around Bournemouth* (Sheet 329), published in 1898, these beds (p. 8) are included in the Bracklesham Series. Prestwich in 1848 (op. cit. *supra*) was inclined to place them in the Barton Series, and the evidence of the fossils which I have collected points to this correlation, for there are no definite or characteristic Bracklesham forms, and all the species identified with certainty belong to the Barton

Beds, and some are typical of them. Mr. Henry Keeping concurs with this conclusion at which I have arrived. Though the material is poor and the fossils not well preserved like those from Barton itself, yet it is probable that further search in dry weather would result in the discovery of other fossiliferous horizons and enable us to fix the line of separation between the Barton and Bracklesham Series in this section.

IV.—*Verruca prisca* from the Chalk of Norwich.

By Thomas H. Withers, F.G.S.

THE Cirripede *Verruca prisca* was first described by Bosquet (1854) from the Upper Senonian and Maestrichtian of Holland and Belgium, and he figured detached examples of all the valves.

Darwin (1854–5) knew of only a single example of *Verruca* from the English Chalk, and this came from the neighbourhood of Norwich. It was originally in the collection of J. de C. Sowerby, but, although search has been made in the Sowerby Collection in the Geological Department of the British Museum, it cannot at present be found. This specimen, which was figured by Darwin (1854–5), consisted of the four valves of the shell united, but without the moveable opercular valves, and it was attached to a Mollusc; Darwin thought it probable that it was identical with *Verruca prisca*, but in the absence of the opercular valves could not say so with certainty.

Verruca prisca has been recorded by Marsson (1880) from the Chalk of Rügen, but I can find no further references to the occurrence of this species.

Dr. A. W. Rowe recently submitted to me a Cirripede which I considered to belong to the species *V. prisca*. The specimen, which came from the *Belemnitella mucronata*-zone of Norwich, is attached to an oyster, *Ostrea semiplana*, and, like the example figured by Darwin, has the four valves of the shell united, the opercular valves being absent. More recently Dr. Rowe sent to me, from the same locality and horizon, a portion of a sea-urchin, *Echinocorys scutatus*, to which seven examples of *Verruca prisca* are attached, and two of these fortunately show the opercular valves in position.

The discovery in the English Chalk of no less than eight examples of this hitherto rare Cirripede is of much interest, not only because they are the only known examples from the English Chalk, now that Sowerby's specimen is missing, but because the presence of the opercular valves has enabled me to determine definitely their identity with *V. prisca*, Bosquet. This species, moreover, is geologically the oldest known representative of the family, and, with the exception of *V. pusilla*, Bosquet,[1] of Maestrichtian age, is the only known species from the Cretaceous rocks. It is certainly a remarkable circumstance that we should find two perfectly complete examples of *V. prisca* having all the valves in position, and I believe them to be the only existing specimens of Cretaceous age so preserved.

[1] J. Bosquet, *Notice sur quelques Cirripèdes récemment découverts dans le Terr. Crét. du Duché de Limbourg*, 1857, p. 5, pl. i, fig. 3.

Family VERRUCIDÆ, Darwin.

Sessile, asymmetrical barnacles, in which the shell is composed of six valves, namely, the rostrum, carina, a scutum, and a tergum, all much modified in shape and immoveably interlocked to form the wall, and a single scutum and tergum which are moveable and form the lid-like top.

The family consists only of the single genus *Verruca*.

Genus VERRUCA, Schumacher.

Most of the species of this genus are known by one, or very few examples only, so that very little can be said of the variability in the individuals of a species. This is especially the case with the recent deep-sea forms, which appear to be more nearly related to the Cretaceous species. It appears to be quite a matter of chance whether the right- or the left-hand scutum and tergum are modified to interlock and form the wall with the rostrum and carina, so that individuals of any species may occur with the moveable opercular valves on either the right or the left side.

VERRUCA PRISCA, J. Bosquet.

1854.	*Verruca prisca*, J. Bosquet,	Les Crust. Foss. du Terr. Crétacé du Duché de Limbourg, p. 14, pl. i, figs. 1–7, 7′.
1854.	,, ,,	C. R. Darwin, Ray Soc. Monogr. Sub-class Cirripedia, Balanidæ and Verrucidæ, p. 525, pl. xxi, fig. 4, and Synopsis et Index Systematicus, p. 626.
1855.	,, ,,	C. R. Darwin, Pal. Soc. Monogr. Foss. Balanidæ and Verrucidæ, p. 43, pl. ii, figs. 10*a–c*.
1857.	,, ,,	J. Bosquet, Notice sur quelques Cirripèdes récemment découverts dans le Terr. Crétacé du Duché de Limbourg, p. 4, pl. i, figs. 2*a–b*.
1877.	,, ,,	H. Woodward, Brit. Mus. Cat. Brit. Foss. Crustacea, p. 144.
1880.	,, ,,	Th. Marsson, "Cirrip. d. Weiss. Schreibkreide d. Insel Rügen": Mittheil. naturwiss. Vereine von Neu-Vorpommern und Rügen, Jahrg. xii. p. 25.
1912.	*Verruca steenstrupi*,[1] K. B.	Nielsen, "Cirripedierne i Danmarks Danien-Aflejringer": Meddel. Dansk Geol. Forening, Bd. iv, Hft. i, p. 39, pl. i, figs. 25, 26.

Specific Characters.—Shell elevated, smooth; lower articular ridge of moveable scutum broader than the upper articular ridge.

[1] Seven examples of *Verruca* from the Bryozoa Limestone (Danian) of Faxe, Denmark, have been recently described by Mr. K. Brünnich Nielsen under the new name *V. steenstrupi*. All the specimens are attached to the inside of the cup of the sessile Crinoid *Cyathidium holopus*, and have the four valves of the shell united, but no examples of the moveable opercular valves have been found with them. To judge from the description and figures, there seems little doubt that they are identical with *V. prisca*, Bosquet.

Distribution.—Maestrichtian and Upper Senonian: St. Pierre, Duchy of Limbourg, Holland. Maestrichtian: Sichen, Belgium. Upper Senonian: Frère, near Tongres, Belgium. Upper Senonian, *Belemnitella mucronata*-zone: near Norwich, Norfolk, and I. of Rügen.

The largest example in the present series is attached to an oyster and measures 4·2 mm. in its greatest diameter from the base of the rostrum to that of the carina, while the specimens attached to the shell of *Echinocorys* range from 1·2 mm. to about 4 mm. in the same dimensions; the two examples with the opercular valves in position measure respectively 1·2 mm. and 2·1 mm. Darwin's figure of the Norwich specimen was enlarged to five diameters, and since this figure measures 24 mm. in breadth, the specimen must have been somewhat larger than the largest of the present series. I have already pointed out that it seems to be a matter of chance whether the moveable opercular valves are on the right or the left side, and the four well-preserved examples show this quite clearly.

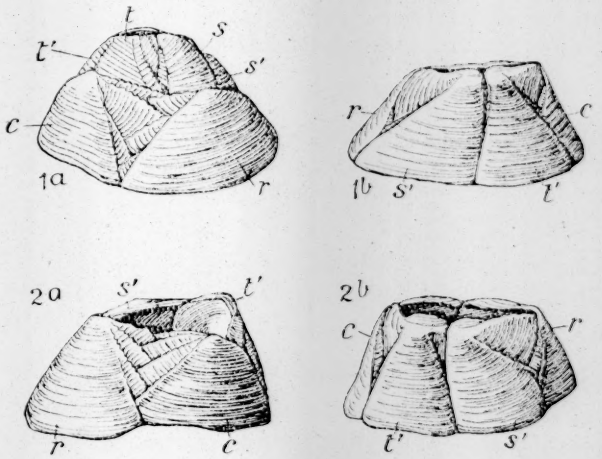

FIG. 1. *Verruca prisca*, J. Bosquet. Upper Senonian: *Belemnitella mucronata*-zone, near Norwich. Complete shell (attached to *Echinocorys scutatus*). (*a*) View showing the moveable opercular valves, which are on the left side; the rostrum and carina have three unequally-developed interlocking ribs. (*b*) Opposite view of same specimen showing fixed scutum and tergum. × 15 diam.

FIG. 2. Id. (*a*) Specimen, attached to *Ostrea semiplana*, with the four valves of the shell united, but in which the moveable opercular valves are missing. The rostrum is to the left hand, therefore the moveable opercular valves must have been on the right side; there are three equally-developed interlocking ribs to the rostrum and carina. (*b*) Opposite view of same showing the fixed scutum and tergum. × 7·5 diam.

r. rostrum; *c*. carina; *s*. moveable scutum; *s'*. fixed scutum; *t*. moveable tergum; *t'*. fixed tergum.

In the specimen attached to the oyster (Fig. 2), and in one attached to the *Echinocorys*, the opercular valves must have been

on the right side, while the larger of the two specimens with the opercular valves in position (Fig. 1), as well as the smaller, have these valves on the left side. It is certainly interesting to note that we have individuals attached to the same supporting surface, with the opercular valves on either the right or the left side.

Darwin pointed out in his description of *Verruca prisca* that the plates by which the fixed scutum and tergum are interlocked with those of the rostrum and carina, were 'less-developed' in M. Bosquet's specimen (from Belgium) than in the English. The number of ribs to these valves appears to vary, however, even among the present specimens from Norwich, since the largest specimen has two, while the smaller specimens appear to have only one. In the specimen figured by Darwin from Norwich, the rostrum and carina have only two interlocking ribs. The specimen on the oyster, however (Fig. 2*a*) and one of those on the *Echinocorys* (Fig. 1*a*) have three interlocking ribs on the rostrum and carina, but these ribs are more equally developed in the specimen on the oyster. The valves (? carinæ) figured by Bosquet (1854, pl. i, figs. 7, 7′ *a*, *b*) from Belgium have five interlocking ribs, and in a valve (? rostrum) in the Geological Department of the British Museum, registered I. 15285, which was obtained from J. Bosquet, these ribs are four in number. There appears, therefore, to be some variation in the number of interlocking ribs in the valves of *Verruca prisca*, as well as some variation in the width of the ribs. An examination of a number of recent specimens of *V. strömia* seems to show that the number of interlocking ribs on the rostrum and carina increases with age, since the larger specimens usually have a greater number.

Owing to the smallness of the two specimens mentioned above with the moveable opercular valves in position, it would be dangerous to attempt to isolate the opercular valves to permit of their more thorough examination. I have given enlarged figures of the two largest specimens, however, and these, I think, will be quite sufficient to show their identity with *V. prisca*.

V.—The Age of the Torbay Raised Beaches.

By A. R. Hunt, F.L.S., F.G.S.

MR. JUKES-BROWNE, F.R.S., in a paper entitled "The Making of Torbay", which has recently appeared in the Trans. Devon Assoc. for 1912, incidentally refers to the Raised Beaches of Torbay as follows: "The age of these beaches has been fairly well settled by the determination of the date of similar beaches in South Wales . . . the beaches testify to a subsidence which culminated either just before or during the epoch of maximum glaciation" (Trans. Devon Assoc. 1912, p. 726).

So long ago as 1849 Mr. Austen (afterwards Godwin-Austen), that prince among sea-going geologists, affirmed that the Raised Beaches of Ireland, Wales, and Devonshire were of the same age. "From the Irish Channel to the western coasts of England, and to those of France and the Channel Islands, we have a continuous series of like

phenomena; and if one portion is of Pleistocene age, so is the whole" (Q.J.G.S. 1849, p. 88). Mr. Jukes-Browne has therefore weighty support to rely upon.

Mr. Jukes-Browne unfortunately makes no reference to the voluminous literature of the Raised Beaches which has accreted round Mr. Godwin-Austen's 1849 paper, literature and evidence extraordinary in its variety—geological, conchological, physical, chemical, petrological, anthropological, archæological; indeed, the subject touches all the old sections of the British Association except economics!

In 1890 my friend and colleague the late Mr. Dan Pidgeon, F.G.S., challenged my 1888 paper at the Geological Society. The following geologists took part in the discussion: Sir A. Geikie, Pres.G.S., Professor Hughes, Mr. Clement Reid, and Mr. Ussher. The earliest date claimed by anyone was Mr. Pidgeon's close of the Glacial Age (Q.J.G.S., vol. xlvi, p. 442).

The late Mr. Gwyn Jeffreys had considered that the analogous beach at Portland Bill indicated a temperature equivalent to that between the Shetlands and the Yorkshire coast at the present time.

The intrinsic evidence of the Torbay beaches against an early glacial antiquity is very strong. For one thing, flints of recognized Neolithic age have occurred at Hope's Nose in Torbay, in the Irish beaches, and in the Scotch beaches, all within the 25 foot level or terrace. The shells of these beaches have been pronounced of a decidedly non-Arctic character.

The most northern shell from a Torbay beach, *Trophon truncatus*, necessitates no further a journey than to the Yorkshire coasts. No shells occur in Kent's Cavern till quite late in the Palæolithic deposits; and, of cockles (undoubted food-molluscs), only in the uppermost inches of the newer stalagmite. The puzzling Pecten shells were, in some cases at least, dead shells when introduced.

The Hope's Nose Raised Beach is about ten miles north of the line joining the Prawle Point and Portland Bill; is in a bay within a bay; and appears inevitably to represent a very much later stage of coast erosion. Further, the vast shore-ledge in the hard rocks at the Prawle in South Devon is open to the Atlantic: the southern Torbay beaches were only open to the eastward and to down-channel seas. In fact, geology, geography, conchology, physics, palæontology, archæology, anthropology, and even micro-petrology, all seem to incline towards the conclusion that the Torbay beaches represent the latter days of the vanishing Glacial Age.

P.S.—The statement that '*Trophon truncatus*' necessitates no further a journey than to the Yorkshire coasts was based on the belief that that shell was extinct in the English Channel. This belief, based on Mr. Gwyn Jeffreys' British Conchology, and never, so far as I am aware, challenged, seems now to be unfounded.

On February 17, the day the proofs of the above communication were posted to me, I visited, quite incidentally, the Hertfordshire County Museum at St. Albans to see Roman antiquities. There Mr. G. Ebsworth Bullen informed me, in course of conversation, that in dredging in the English Channel from the Plymouth Marine

Biological Station he had taken *T. truncatus* in mid-channel, and that it also occurred at Guernsey.

So much for a quarter of a century's negative evidence, and the testimony of the fauna of the Torbay Raised Beaches to a rather colder temperature.

VI.—The Picrite of Foel lwyd, Carnarvonshire.

By J. E. Wynfield Rhodes, B.Sc.

DURING a short holiday to North Wales in Whit-week, 1910, I was investigating the igneous rocks to the south of Llanfairfechan, more particularly the intrusive greenstones of the Geological Survey map. Since the publication of this map, over fifty years ago, several districts within it have been investigated in greater detail, especially as to the volcanic rocks, but much remains to be done petrographically. One of these greenstones turned out to be of exceptional interest, being of a type of rock hitherto, I believe, unrecorded in North Wales, so another visit was made to it in August, 1912.

My attention was drawn to it in the field by its pronounced lustre-mottling, and a fuller investigation revealed in it strong affinities to the augite picrites. It occurs on the southern side of the height Foel lwyd, overlooking the celebrated Bwlch-y-ddeufaen Pass, which connects Aber with the Conway Valley, and outcrops on a dip-slope, which owing to the steep southerly dip is often precipitous. Owing to the interstratification of grits, shales, and igneous rocks, the side of the hill is terraced, each hard band forming a crag. One of these, the lowest, is composed of the rock in question, and it appears to form a sill-like mass, possibly a phacolite, intruded between the grits and shales overlying the so-called Bala Volcanic Series. It appears to send off veins into these rocks. It dies out horizontally, and at the same time the feature ceases to be traceable. The crag is heavily glaciated, although, owing to extensive weathering, striations are not evident.

Petrology of the Intrusion.—In hand-specimens the rock is of a medium grain and of a dark-green colour, becoming lighter on weathering; notable in most specimens for its lustre-mottling. Serpentine bulks to the extent of one-half the rock, diallage is abundant, and felspar is usually to be detected; pyrites occurs locally. Microscopically the rock is seen to contain—

Serpentine, pale green, fibrous, nearly isotropic, interstitially and as granules up to ·03 inch in diameter embedded in augite, apparently pseudomorphing olivine, which must have been the most abundant constituent of the rock.

Augite, in large pinkish brown prisms and grains up to ·16 inch in diameter, with a very pronounced diallage striation, enclosing olivine pseudomorphs (poecilitic structure) and plagioclase laths (ophitic structure); next to serpentine the most abundant constituent.

Bastite, fairly abundant in the serpentine in flakes up to ·01 inch in length.

Ilmenite, in allotriomorphic grains and rhombohedra strongly altered to leucoxene, up to ·22 inch in size (usually smaller), present in small amount only.

Plagioclase, in laths from ·01 to ·02 inch long by ·002 inch wide usually, often much decomposed, well distributed but subordinate in quantity to augite.

Apatite, in very small prisms not exceeding ·003 inch long, and very scarce.

The order of crystallization seems to have been apatite, plagioclase, ilmenite, enstatite (represented by bastite), olivine (represented by serpentine), and lastly augite.

Two varieties of the rock were distinguished: (1) the normal rock, forming the bulk of the intrusion, in which felspar though a constant constituent is not present in large amounts; (2) a more felspathic variety, lighter and greener in colour, occurring at the margins, top and bottom, of the intrusion. It may be suggested that it is the result of differentiation by fractional crystallization, the felspar being the first essential mineral which crystallized in the rock.

In microscopical structure the normal rock is more of a picrite than a dolerite, especially in the dominant role played by olivine in the crystallization of the rock. This interpretation is confirmed by the partial analyses of two specimens which yielded 45·07 and 45·4 per cent of SiO_2 respectively. On the other hand, there is certainly more felspar in the normal rock than in the most typical picrites, though there is hardly enough for a dolerite, even in the felspathic variety. Augite picrites and olivine dolerites are alike hitherto unrecorded from this district. The nearest outcrops of such basic rocks are the hornblende picrites of the Lleyn Peninsula and of Anglesey.

VII.—The Upper Trias of Leicestershire.

By A. R. Horwood.

(*Continued from p.* 86.)

3. Stratigraphy (*continued*).

THE *Dane Hill Sandstone Group*, as we propose to distinguish the higher of the two series of Upper Keuper sandstones, since it is well developed in the neighbourhood of the Dane Hills at Leicester, is well exposed in a little quarry at Ashleigh House. Here the highest part of the series is seen, with thin beds of flaggy marl and calcareous White or Green Marl, overlying a series of thick-bedded, current-bedded sandstones, of white colour, loose and friable, but hardening on exposure. The section has been described by Browne (1893), but at present is exposed to show a better sequence (see next page).

On account of the prevalence of *Estheria* in the marly beds and *Acrodus* in the sandstones they may be distinguished as *Estheria* Marls and *Acrodus* Beds, and the beds below the last as the *Annelid* Bed.

		ft.	in.	
	Humus	1	0	
Estheria Marls.	Brown false-bedded sandstone	0	8	(to 1 foot).
	Fissile green marl	0	2	
	Flaggy brown sandstone	1	0	
	Fissile green marl	1	6	
	Thin flags of sandstone	0	3	
	Fissile green marl	1	0	(to 15 inches).
	Thin layer of marl	0	1	(to 2 inches).
	Sandstone	0	6	
	Fissile marl	0	1	
	Brownish-white sandstone	0	8	
	Fissile marl	0	3	
Acrodus Beds.	Coarse white sandstone	1	0	(to 15 inches).
	Thin marly parting	0	1	
	Coarse sandstone	1	0	(to 18 inches).
	Marly band	0	2	
	Sandstone partly false-bedded	1	6	(to 2 feet).
	Marl band	0	1	
	False-bedded white sandstone	2	6	
	Marl band	0	1	
	False-bedded white sandstone	2	0	(to 2 ft. 6 in.).
		15	7	(to 18 feet).

It will be seen from this that the marly beds are mainly developed above the sandstones. It is in these that abundant traces of *Estheria minuta* occur, but occasionally they are found in the coarse sandstone. Plant-remains and tracks of Crustacea or Annelids occur on the upper marls, but are fragmentary. Some marl bands have carbonaceous bands, especially the lowest. In the sandstones are fin-spines of *Acrodus keuperinus* and teeth of *Acrodus*.

The petrology (*supra*) of these sandstones indicates their fluviatile origin, there being two sizes of grains, none of which show the polished character of desert sands. Kaolinized grains of felspar are abundant, with a varying proportion of heavy minerals. The flaggy beds are ripple-marked and show indications of raindrops and sun-cracks. The sandstones are false-bedded to the south-east, in which direction they thin out, whilst the marl beds, like calcareous strata in normal aqueous deposits, thin out in an opposite direction to the north-west or west. A section showing this was exposed in the Hinckley Road, and was figured by Fox-Strangways.

Recently the hilly ground between this quarry and the New Parks has been opened up for building purposes, and the thick sandstones, here much browner and with numerous black spots, have demonstrated the extension of the beds in this direction. That they were extensive northwards to Newfoundpool is shown by the numerous pits in the hill upon which the new Convent is built. To the east about Dane Hill a lenticular patch is shown by their outcrop and by excavations. A valley separates this tract from the Ashleigh House outcrop and the Shoulder-of-Mutton Hill district. This area is now known as New Parks. In the Western Park, south-west of the Convent, a ballast cutting made when the adjacent railway cutting was excavated shows 8 ft. 8 in. to 15 feet of the sandstones with no

overlying marls. These are covered by Drift, and the section is as follows:—

		ft.	in.	
	1. Drift, with quartzites and flints	12	0	(to 15 feet).
Acrodus Beds.	2. Thin laminated sandy flags	0	9	
	3. Thick-bedded sandstone	6	6	
	4. Parting of green marl	0	4	
	5. Thick-bedded reddish-brown sandstone, current-bedded to north-east, with white specks of kaolin and green clay galls	2	0	(to 2 ft. 6 in.).
	6. Green marl	0	4	
	7. Thick-bedded sandstone	0	9	
	8. Thick-bedded brownish-red sandstone	3	0	
		25	8	(to 24 ft. 2 in.).

The top beds contain numerous fin-spines of *Acrodus keuperinus* and teeth of *Acrodus*. *Estheria minuta* occurs in the marl partings. One part of the section to the east shows undulating strata.

In the railway cutting are 6–7 bands of sandstone, and at the west end green marl and gritty sandstone, 6 feet, below the sandstones, which are 20 feet thick. The upper marly beds are absent here. Some marly bands under the bridge are intercalated in the middle of the sandstone beds and exhibit a delta-bedded character dipping to the east. The false bedding at Ashleigh House is similar in parts, having a curved, not straight outline. This cutting is about a mile in length and the beds are finely exposed. Fossils were obtained when the line was opened by J. Plant (see Palæontology), but are difficult to obtain now. Many occur in the flaggy basement beds. Where the Glenfield footpath crosses the line the outcrop forms a branch striking north-west towards Braunstone Frith.

These sandstones are continuous northward along the west bank of the River Soar as far as Mountsorrel, but the outcrop is discontinuous. It is in the Dane Hill or New Parks district that they are best developed in Leicestershire. The similarity of these beds to those in the Warwickshire area, as described by Brodie, is very close, not only lithologically but also from the palæontological point of view. Brodie and others have found the Warwickshire Sandstone more prolific in number of species, and plants especially are better preserved there. This may be due to local conditions, and is not the result of less interest in the formation in this county. The question of the peculiar distribution of the Triassic flora and fauna will be discussed elsewhere.

Turning to the surrounding area in which borings have been made for coal through the overlying Trias, reference may be made to one at Stretton Baskerville (300 O.D.). Here under 130 feet Drift, etc., 242 feet of Keuper Marl, 250 ft. 6 in. Lower Keuper Sandstone reposed upon 58 ft. 6 in. Caldecote volcanic rocks. This thickening of the Lower Keuper to the south is supported by similar sections to the north. The south-easterly attenuation in Leicestershire and district is apparently everywhere modified in proximity to the older rocks.

At Weston, near Bulkington, 300 feet clays, marls, and sandstones,

with a bed of limestone half-way down, were attributed by Andrews to the Coal-measures, showing an attenuation of the Trias in this direction. At Combe Abbey to the south, however, 180 feet Red Marl, 75 feet white sandstones or waterstones overlie 25 feet Red Marl, probably Permian or Upper Coal-measures. At Brandon, south-east of this, the section was—

		ft.	in.
Soil		2	6
Gravel		18	6
Keuper Marl		277	0
Waterstones		36	0
Broken ground		6	0
Coal-measures with coal	Black Shale	5	0
	Blue Shale	21	3
		366	3

This shows an attenuation of the waterstones to the east. At Copswood Grange, near Stoke, there were 60 feet Keuper Marl, 82 feet grey waterstones, 97 feet brown and red sandstones, showing a thickening of the middle series again to the west.

(4) *Charnwood Forest District.*

The Charnwood range is circumscribed by the Leicester and Burton line, the Loughborough and Coalville line, and the Loughborough and Leicester line. Since the last runs to the west of the Triassic outcrop on the east, this area is not strictly included within the last boundary, and the outlying tracts are here included up to the Tea-green Marls.

A feature of this area is the unusual manner in which the Trias reposes against the older rocks, seen to some extent in proximity to the southern syenites of Croft, etc., but better displayed with the usual radial dip in this area. There is little or no necessity to enlarge on these features, as Professor Watts and T. O. Bosworth have done so elsewhere, with a different interpretation of these features. It is not the purpose of this paper to enter into discussion as to the causes of these abnormal phenomena in the marls, but simply to record their occurrence. In doing this also features described by the foregoing authors will not here be referred to except where a different account can be given in the light of fresh knowledge. My views as to these phenomena have already been outlined in abstract, unfortunately too briefly to adequately explain my contentions, and a fuller account will be published shortly elsewhere. This will obviate any special allusion to these matters of purely local occurrence in this paper. In the north-west of this area there are exposures of the Lower Keuper Sandstone, and though some writers have stated that it does not encircle the Charnian rocks, yet there are several points in this district where it undoubtedly does.

The Red Marl reaches its highest altitude in Britain here at Bardon Hill, and throughout this district west of the Soar Valley rises generally to a more or less uniform altitude of 500 feet on the west down to 300 feet on the east. Owing to the contact of the Red Marl with the older rocks numerous opportunities of studying it are presented, of

which the most interesting sections are here mentioned. In addition the Red Marl is largely used for building purposes, brick- and tile-making in the Soar Valley, and it has been possible for the first time to indicate the correlations of these sections and the position of the beds in the sequence. Some of the most important sections in the Red Marl are to be seen in this vicinity right up to the Tea-green Marl and overlying Rhætic beds. A considerable influence has been brought to bear upon the configuration of the Red Marl by the river-systems, which owe their origin in this area to the Charnwood range, and the River Soar to the east is responsible for the development of the fine series of sections just mentioned.

In the extreme north-west at Gracedieu the basal breccia of the Lower Keuper is seen to overlie the limestone, unconformably, the latter dipping north at 6–10 degrees. There is a limestone breccia at the top in a sandy red matrix, which between here and Griffy Dam is much more brecciated than to the north-west. Between Spring Boroughs and Blackbrook the Lower Keuper Sandstone overlaps the Charnian rocks for a distance of half a mile. It runs up the Blackbrook Valley, and is in turn overlaid by Red Marl which occupies a broad strip in the centre of the valley, dividing the forest into two halves more or less along the anticlinal axis. At Finny Hill Lodge this tract is nearly a mile in width. In these Red Marls there is a bed of white sandstone near the base, which probably represents the white skerry band at Bardon Hill, and those at Copt Oak and Charley. About White Horse Wood or south of it these marls with an interbedded sandstone are seen, and further north a bed of white sandstone has been found to contain galena included in Carboniferous Limestone, and derived from some of the inliers to the north-west. There used to be several old marl-pits in this district in the valley in a lane opposite the wood with a floor of fine light-coloured sandstone, which dipped towards the valley (west) at 8°–10°.

Thirty years ago Shipman discovered galena in the Lower Keuper Sandstone at Shepshed in cuttings for the Charnwood Forest Railway, 1 mile south-west of the village, in a coarse red sandstone under the bridge over the road from Shepshed to Blackbrook. The ore was in pebbles and rolled lumps of impure Carboniferous Limestone, and formed 50–60 per cent of the matrix, which resembled the Dimminsdale type where galena occurs in situ. It was formerly worked here.

A mile to the east the Lower Keuper Sandstone thins out. In the boring to the north (District I), at Piper Wood, No. 1 (230 O.D.), Carboniferous Limestone and Millstone Grit were met with, with no Red Marl or sandstone, but in No. 2 there was 46 ft. 6 in. Probably the galena came from some such concealed ridge of limestone, and doubtless the Lower Keuper was derived locally largely from Bunter pebble-beds and the Millstone Grit, the grains in each having some considerable resemblance.

Further east, at Longcliffe Quarries, Red Marl lies horizontally upon the upturned edges of the syenite, with green and white skerry bands. In the top quarry there is much more Red Marl (10–20 feet) with an interbedded band of gritty brecciated sandstone or sandy

marl. The fragments of weathered syenite are triangular or sharply angular or pentagonal in cross section, 1 × 3 inches; others are small, and make up a gritty paste. The marl and sandy matter are all composed of local rocks and are highly saturated with iron oxide. In the top quarry only a few bands of skerry run through the Red Marl on the east side. Along the west side in the top and bottom of the top quarry they are more frequent and closer, approximating to thick but laminated beds of sandstone, probably equivalent to the Bardon skerry. They dip away to the south-west on that side. In the second quarry at a lower level on the west side thin beds of flaggy marl and sandstones and an interbedded thick sandstone with larger grains of quartz and felspar, etc., dip away gently on either side from the dome of granite, and when covering it they reunite and form a continuous but slightly undulatory band, following the dome structure above, but becoming horizontal away from the latter. The dome strikes north-west by south-east, and is on the line of the anticlinal axis. The marl beds are identical on either side of it, and merge into a thick white band at one point, as at Bardon and Hathern (in the Red Marl), of kaolinized minerals. A similar structure is seen at Enderby, which is a continuation of this axis, where the Trias follows the dome structure in a similar manner. Along the east side of the quarry skerry bands are aggregated into a thickly laminated bed which lies just over the syenite, with an even more or less horizontal bedding. Ripple-marks occur on more than one side of the flags of skerry, bluish in colour here, and their direction is in the upper ones north-west by south-east, in the lower north-east by south-west. These beds belong to the waterstones.

At Forest Gate Keuper Marl covers the roofing slates, and at the base are pebbles of quartz and breccia lying on the upturned edges of the slates.

Turning to the western boundary again, in the Whitwick Shaft (530 O.D.) 191 ft. 3 in. Red Marl and sandstones lie over the thick bed of dolerite, with white sandstones 3–4 feet thick and Red Marl with waterstones. At the Coalville Waterworks boring (537 O.D.), 300 yards south of Whitwick Waste Farm, there were 113 feet of drift, 47 feet of Red Marl, and 100 ft. 10 in. of Lower Keuper Sandstone, overlying dolerite, green in colour. The beds in this section were very abnormal, being purple in part, with fine breccia like some Permian and Upper Carboniferous types.

At Bardon Hill, in the third quarry from the bottom on the south side, there is a V-shaped gully filled with Red Marl and angular blocks of the local rocks, overlaid by a horizontal band of Red and Yellow Marl, rather gritty, and, like the scree, full of fragments of local rocks. At two points yellow bands run down at right angles to the others in a vertical manner. The gully trends north-west by south-east, a similar gully being seen in section on the north side. This coincides with the ripple-marks.

In the fourth quarry [1] from the bottom, on the south side, horizontal

[1] Along the top of this quarry run two beds of skerry which above show white marl made up of kaolinized minerals at 800 feet.

bands of Red and Yellow Marl lie directly upon the older rocks. The lighter sands are quite yellow, others distinctly ferruginous and sandy. Some dark-red bands are full of local fragments of rock, often coated with lighter marl and manganese. In the cutting from the south the Keuper dips away to the south-west. A fault traverses the north side west and east. In the fifth or old top quarry in the centre of the east face there are cracks running vertically down through the old rocks filled with Red Marl at 880 feet. Horizontal beds of Red and Yellow Marl recently exposed to the north rise from the floor of the quarry. All the joints of the rocks right up to the top are stained with Red Marl. The beds in situ resemble those at a lower level and contain much local rock, and are much browner in tint than further off. W. Keay and M. Gimson have remarked upon the extraordinary height to which these beds rise above the surrounding country, the highest Trias in Britain, and add that it must have been deposited from a much higher altitude than 880 feet, and this would mean the total submergence of Bardon Hill. The beds dip 1°–3° to the south-east, and taking into consideration their distance from the Rhætics at Leicester there must have been a thickness of 200 feet of Red Marl above the present level. In the new quarry on the north side the newly-exposed surface of the rocks here is untouched by wind action and presents a well-preserved surface. Messrs. Keay and Gimson were unable to find any such traces where, as one would expect, the old shore-line here once was.

Along the road from Copt Oak to Charley Lodge there were formerly pits in the Red Marl with red clay above of glacial origin (700 feet). In a field 400–500 yards on the north-east the Red Marl contained regular white soft sandstone horizontally bedded. The valley between Copt Oak and Charley is filled with Red Marl in which a similar sandstone occurs, the same as the skerry at Bardon.

To the east a boring at Newtown Unthank (280 O.D.) showed drift 8 ft. 6 in., Red Marl 211 ft. 10 in., Lower Keuper Sandstone 155 ft. 3 in., and 242 ft. 2 in. Coal-measures. At Botcheston in an old pit a skerry crops out in the brickyard, which is probably on the same horizon as the Orton-on-the-Hill Sandstone.

At Kirby Muxloe, Barron Park, a boring showed soil and drift 36 ft. 11 in., Red Marl 80 ft. 5 in., and igneous rock (augite syenite) 1 ft. 2 in. The Red Marl is bleached with organic matter and contains grey markings traversing the rock in vertical and diagonal lines, due to acids in solution which have deoxidized the marl.

The Red Marl is exposed near the Holy Well at Ratby not far from the Roman Camp, and here presents a sandy character as at Thurmaston. In the brick-pit at Glenfield Drift overlies Red and Green Marls, used for brick- and tile-making, similar to the beds seen at Groby.

A conglomerate lies near the base of the Keuper in the Groby quarries. There is also much scree. At the Dowery Quarry variegated bands dip away from the syenite, and in the Large Sheet Hedges Quarry horizontal bands lie over the syenite at various points with a scree at the base. These beds are also extremely sandy, less marly than in the surrounding district. It is certain that to

some extent the horizontal appearance around these knolls of older rock is partly illusory, but allowing for the angle of rest of beds lying upon inclined slopes this radial dip is a natural feature of aqueous deposits. In the Ansty Paper Mill boring (225 O.D.) 70 feet of drift and 117 feet of Red Marl and gypsum, higher up in the series than the last sections, was met with.

Several trial holes on the Beaumont Leys estate penetrated the Red Marl at high elevations. Where the Great Central Railway crosses the valley to the east sections in Red Marl are to be seen, and west of Leicester Abbey old pits in the field show 10–15 feet of sandy Red Marl with gypsum bands. In the Ansty Lane the Red Marl is cut through by the stream. A sandstone upon the same horizon as the Dane Hill Beds is seen to the north at Birstall, but makes no marked feature, and in this direction it is only where the River Soar has excavated its broad and deep valley that it reappears to any great extent.

Turning to the Red Marls in the Soar Valley just north of Leicester, at the Star Brick-works at Thurmaston, 12–15 feet of Red Marl, 4 feet of which is spotted with green, much harder at the base, is exposed. The basal marl is more calcareous and resembles that of No. 13 at Barrow's pit (east of the Midland Railway) or No. 6 Vass's pit, irregularly bedded and less nodular. In the last 4 feet the green patches are irregularly distributed in more or less parallel bands here and there, uniformly elsewhere. A loose piece of sandy marl contained casts of Crustacean or Annelid tracks, perhaps glacially derived from the Dane Hill Series. The nodular concretionary marl at the base is full of cavities and honey-combed, and is more impregnated with iron. The concretions are probably upon the same horizon as a gypsum band, and represent a further stage of the loose anastomosing veined patches, where there was insufficient sulphate and more carbonate of lime, so that no gypsum was precipitated. At the Thurmaston Pottery to the north a coarse-grained skerry crops out here, which finds its equivalent at the Thurmaston brickyard. But at the last locality it has thinned out, and is there just an ordinary skerry. At Gipsy Lane a hard pink skerry occurs at the base of the thick green band over the gypsum, but these are not equivalents. The skerry is even coarser than the Dane Hill Sandstone, which disappears east of the River Soar. It is intercalated in Red Marl, which is used here for making tiles and pottery, the marl readily lending itself to the lathe.

In the Thurmaston Brick-pits excellent glacial sections are to be seen over Red Marl and gypsum down to a depth of 27–40 feet. To the south the Red Marl is very sandy and highly ferruginous, easily breaking into sand. To the south again the anastomosing fibrous gypsum takes the place of the compact gypsum seen in the railway cutting, and there is about 2 feet below a layer of skerry. At the north end the compact gypsum is in isolated masses, as often happens at Gotham, with marl between. There is no appearance of subsequent formation, and it must have been formed originally in separate hollows or pans. The reticulating veins of gypsum at the south end present a marked contrast to this. It is rather higher,

showing that the bed dips to the south-east. The Red Marl is similar to the lowest layer at Barrow's pit (west of the Midland Railway). The skerry band resembles the dolomite band at Vass's pit. Seen in section the anastomosing veins of gypsum terminate abruptly with broken ends, crossing and intersecting at all angles. Some larger veins stand out more prominently.

In a disused pit near the Victoria Road, Humberstone, 11 ft. 9 in. to 18 ft. 6 in. of Red Marl, with green marls and skerry and two bands of gypsum, is seen. The gypsum is here occasionally coated with selenite crystals. The ball gypsum contains cavities filled with Red Marl. One thin laminar piece of gypsum was embedded vertically in the Red Marl, with a pitted and decomposed surface. One piece had a line of oblique cavities at intervals on the uppermost part.

At the Gipsy Lane Pit there is a fine section from Rhætics downwards: 15 ft. 3 in. of Tea-green Marl, with seven nodular bands overlying Red Marl, skerries, and gypsum, 69 ft. 9 in. to 77 ft. 9 in., or nearly as deep as the Glen Parva section, but beginning lower down and so carrying on the sequence. Moreover, it is the nearest available section of these beds to Leicester. The Tea-green Marls are not so green as at Glen Parva. The same courses of nodular calcareous marly bands as at Glen Parva, where fish occur, are seen. The whole formation is much more calcareous. The supposed discolouring of the Tea-green Marls from red to green or grey does not obtain here, since the Rhætic beds are of no thickness. There is no bone-bed, and the Black Shales are not characteristic. The variegation of the Red Marls below the Tea-green Marl here is well shown. In fact, this is the best section in these upper beds. The Red Marl varies in colour from pure red to brown or chocolate. In places it is pink, especially where in contact with green or white bands. It is often coated with powdery oxide of manganese, and the faces of the nodular structure are spotted black with the same. The Red Marl is usually nodular, and at this horizon is seldom shaly or laminated. It does not assume a loose sandy character as at some adjacent exposures, except at the base. The red bands are parallel with the green or white, with some exceptions. The green bands are made up of marl or skerry, or gritty sandstone. There is a preponderance of these narrow bands alternating with the red bands at this horizon. One band is especially thick and well-marked at 10 feet (*circa*) from the top. It is on the laminæ of this that the ripple-marks seen in situ (north-west by south-east to north by south) occur. While the Red Marl consists very largely of fine quartz-dust, etc., and is but slightly calcareous, the green skerries, which also have a greater specific gravity, are much more calcareous, and the separate particles are larger and more varied in composition. Large grains of pink felspar, with others white and decomposed, are common. Many of these bands are largely dolomitic, and, as at Vass's pit, are full of cavities. The skerry bands show evident laminæ and lines of stratification, and are not nodular. There are lines along which the particles are graded into different sizes.

The gypsum is of four types—(1) thick-bedded, tabular, compact, often impure, and streaked with marl; (2) ball gypsum, plano-convex

in form, spheroidal, pure, and very hard; (3) fibrous gypsum or satin spar, having the crystals vertically arranged; (4) selenite, having a typical crystalline form, often twinned, or in laminæ, or plates. The selenite is often encrusted upon the outside of the ball gypsum, and is stained a chocolate colour. The gypsum is white or yellowish-white, pink, or greenish, especially when traversed by Green Marl. The latter may under- or overlie a seam of gypsum. Fibrous gypsum passes laterally into ball gypsum, and often anastomoses. Pseudomorphs of salt crystals are abundant upon the surfaces of the green bands, varying in size from $\frac{1}{4}$ to $\frac{5}{8}$ inch across. They are associated with ripple-marks.

There is an interesting case of what may be regarded as undulatory bands of coloration, where a thick green band below the thick gypsum band exhibits a dip or syncline, transgressing a chocolate band below. The bedding is horizontal throughout, and this shows that coloration here, at least, is secondary to bedding. On the view that the green coloration is original and the red due to percolation by influx of chalybeate water, as held by Dr. Moody, the red coloration of the lower band must have been applied from below upwards, and the dip in the green colour would be due to the different porosity of the latter, or its composition influenced by its greater specific gravity.

The ripple-marks trend north 20° west. They are practically upon the top of the thick green band near the top of the section. This is not seen elsewhere,[1] for at Glen Parva the floor is upon a layer of pink granular gypsum. In some parts the top is covered with small slabs (1 × 1 × 2 inches) of this granular salmon-pink variety. At others there is a peculiar hard pink kind of skerry passing into greener marl with a pink layer of gypsum below. The hard pink layer is semi-crystalline, and resembles the band at Vass's Brickyard, into a form of which it passes, containing here and there hollow cavities, and in large measure also dolomite. The steeper side of the ripples faces north-west, so that the direction of any current would be at right angles, i.e. from the south-west.

At Vass's brickyard, a little to the north, a section 14 ft. 4 in. to 26 ft. 6 in. exhibits Red Marl with three Green Marl and skerry bands, and a floor of gypsum. The marl here is not so hard as at Gipsy Lane, being more sandy. I found some pseudomorphs of salt crystals on what were apparently Red Marl slabs, but subsequent examination showed that it had been stained red. Mr. Whitaker, I believe, has found pseudomorphs on Red Marl. The junction of the red and green bands is irregular, with concretionary masses. The dolomite with hollow cavities contains casts of what might be taken for organic structures, but they are too indefinite to base any decided opinion upon as yet. A curious skin is to be noticed upon the exterior of some of the gypsum, which lies here nearer the surface than at Gipsy Lane, and this must be due to recent chemical change, just as another block of ball gypsum was pitted and fretted.

In Barrow's pit, east of the Midland Railway, 33–46 feet of

[1] Except near Gotham.

Red Marl and Green Marl and skerries with five gypsum bands are exposed. In the top band the gypsum passes laterally into Green Marl. The third band thins out to the north. The second band is fibrous. Between the north and south end of this pit the extent and number of the gypsum bands is very variable. It represents the lower part of the Gipsy Lane section. Bed 13 is more massive, and jointed. Below bed 11 the marl is exceedingly hard, and impregnated with selenite crystals, like some Upper Rhætic shales. The skerry in No. 10 is dolomitic and full of drusy cavities, as at Vass's pit. The gypsum varies greatly in colour from white to greenish-white, yellow or orange to salmon-pink. The upper surface may be covered with spheroidal concretions or is even. The satin spar is often tinged pink. In this and other cases there is abundant evidence that the red colour is secondary. The ball gypsum is exceptionally well developed, showing the plano-convex structure admirably. The masses are isolated, but arranged in horizontal layers.

In Barrow's pit, west of the Midland Railway, 16–28 feet of Red Marl and Drift is seen in section. The Red Marl resembles that of the Belgrave Brick Company's and Star Brick Company's works, and is stiff and tenacious down to the floor, which is the same as the base of the Belgrave Pit. The bedding is regular and uniform, each bed retaining the same characteristics throughout, and no better evidence of aqueous deposition could be desired than so clear-cut a section. If the variegated beds convey this impression by their regularity and horizontal bedding, a section such as this, without them, adds additional emphasis to the matter. About 12–16 feet of Red Marl below soil and river-gravel is exposed at the Belgrave Brick Company's pit adjoining. The Red Marl is the same as that at the Star Brick Company's works, and is very nodular, splitting into rounded nodules, and contains much manganese. Spots of Green Marl occur in the Red at the Star Brick Works. This pit is continuous with Barrow's pit west of the Midland Railway, from which only a bank separates it, and in the latter the floor is used for growing cereals, which do well on the sandier beds.

On the west side of the River Soar the coarse sandstone representing the Dane Hill Sandstone is seen in the Cossington district in the Fosse Road above Lewin Bridge, in the lane leading thence to Cossington, and the ridge flanking the Soar Valley on the west is caused by the feature it forms. By the River Soar west of Syston sandy Red Marl with skerry crops out in the river banks.

From Chellaston southward gypsum bands can be traced by Gotham Sileby to Queniborough and Thurmaston, and south of Leicester at Blaby. It is found in a pit east of Syston on the Queniborough and Barkby road, where a very uniform thickness (30–40 feet) of Red Marl with few green bands representing the lower part of the Gipsy Lane Pit is to be seen.

From Gipsy Lane northward the Tea-green Marls can be traced nearly to the fault north of the Humber Stone. North of Barkby-thorpe they are only seen just here in a few isolated exposures.

A coarse sandstone of the Dane Hill Sandstone type is seen near Rothley. In the Great Central Railway cutting at the station at the

bridge under the road to Rothley sand terminates abruptly against Keuper Marl, a feature noticeable in these drift sands. The Upper Keuper Sandstone at Ratcliffe is seen in the village, where it is thicker than at Rothley. It crops out in the west bank of the Wreake, south of the mill, where it is intercalated between sandy Red Marl and Green Marl. At Shipley Hill long barrow the marl is evidently made ground.

At Sileby there is an interesting section of Red Marl at the Phœnix Brick-pit. The section is 61 feet thick. In bed 2 there are irregular markings, chiefly vertical, of Green Marl running down into the Red. Irregular green patches are seen in the bed 3 also, and in beds 4 and 29. There is a good deal of skerry at certain horizons, which is useless for brick-making. This pit is especially interesting, as it exhibits well the irregular deposition or variegation of the Red and Grey Marls. Long streaks of Grey Marl depend from a horizontal layer into the Chocolate Marl, as though having gradually trickled down or fallen into it when liquid. This never happens, on the contrary, in an opposite direction, i.e. Red Marl never exhibits this arrangement when overlying Green Marl. This seems to favour the diffusion column idea, and that the Grey Marl is heavier than the Red. When the Red Marl is irregular at the base it takes a concave form, which indicates an overlapping of the red colour upon the grey, irrespective of bedding.

There are five pits in the adjoining Albion Works in this series of workings, all of which exhibit the same section as at the Phœnix Works (upper part). In two, one to the north of the cutting and bridge, there are instances of Red Marl showing a saddle-like roll, as though indicating a local instance of a subaqueous dune. In the last case one is seen on the east face and another on the north face, and it is possible that the two were connected by a circular sweep which would give roughly a south-west and north-east direction for the force moving it. In the other quarry, seen from the railway, two such rolls occur in the Red Marl lying over each other on the north face, and the intervening Grey Marl follows the same course. Others occur on the east and south faces. They are practically all at one level, and have not been noticed elsewhere. This district has been much disturbed, and it is possible these undulations have some local connexion with the same phenomena or perhaps colour distribution.

At Mountsorrel on the opposite side of the Soar, in the large quarries along the north-west faces near the top, Trias fills the hollows. It lies quite horizontally against the granite, with no radial dip. Blocks of granite lie at the base of the marl in the hollows, as do the Charnian rocks at Bardon. Some are rounded, but not all.

Upon Castle Hill the blocks of granite are quite angular on the south and east sides; but along the north and west sides, or from half-way along each side of the last, they are smoothed and polished, doubtless by wind action. The extent of the polishing is not very marked considering their exposed nature, nor could the period at which they were polished be determined from the overlying deposits. Where covered at all they are covered by drift.

Professor Watts, who described the wind-polished rocks at Hawcliff Hill, not now visible, has remarked that where the Red Marl forms a junction with the isolated bosses of granite the sides are very precipitous, showing that they formed "peaks and nearly vertical cliffs in the Triassic sea". Wells sunk in the Keuper close to the granite go down to a depth of 100 feet.

At Nunckley Hill the Keuper Marl is covered by Boulder-clay, and on the west side it abuts against the granite, large blocks lying in the Red Marl "as if they had fallen from a cliff during its deposition". The viaduct is built upon Red Marl lying against the granite. In the valley west of Quorndon the Great Central Railway is in Red Marl up to Rusheyfields Lane. There is a sandstone in the Red Marl at Buddon Wood full of drusy cavities, which is probably the Dane Hill Sandstone. Here also the edge of the granite is very steep where the Red Marl abuts against it.

Between District (1) and Loughborough the Red Marl is much covered by drift. At Loughborough Lane there is a scree at the base of the Red Marl overlying the older rocks.

In the Swithland Slate Quarries, as noted by Jukes, the Red Marl rests horizontally on the upturned edges of the slates, and the bedding of the Red Marl follows at the base the uneven surface of the slates, ascending over the rising portions, and in the hollows following the depressions. Harrison came to the correct solution that this conformity of the marl with the irregularities of the floor on which it lies is due to the natural manner in which deposits repose on slopes and hollows.

At Woodhouse Eaves Red Marl penetrates the valleys in the Charnian rocks, lying in the hollows. As on the north and at Copt Oak, a skerry or white sandstone probably representing a band low in the marls forms a floor in the pits where the marl has been used for brick-making, now disused.

In a small cutting in Red Marls and green skerries pseudomorphs of salt crystals occur at Beaumanor. At Quorn Station the Red Marls to the south are very sandy, as nearer Leicester.

George Maw, 1868, first noticed that "the Red Marls of Charnwood Forest dip away in every direction from the high ground of the older rocks towards the surrounding level plain. But I was much struck with the fact that the direction and amount of inclination seemed to be less related to the entire mass of the high ground than to its details of contour. Another noticeable feature of Charnwood Forest is the relation of the areal outline of the Red Marls to the surface contour of the older rocks rising above them, long winding tongues of the red beds running up into the ancient valleys of the high ground, the contour of the exposed portions of which is entirely in harmony with that of the bottom of valleys buried beneath the remnants of the later deposit". He remarks, further, on the antiquity of the hill and valley system, the absence of marine erosion, and the antiquity of the ancient lines of waterflow (pre-Triassic).

(*To be continued in our April Number.*)

REVIEWS.

I.—The Stratigraphy of the Chalk of Hants. With Map and Palæontological Notes. By R. M. Brydone, F.G.S. 8vo; pp. 1–116, with 3 plates and coloured map. London: Dulau and Co., 1912. Price 10*s.* 6*d.* net.

THE publication of this work, comprising the results of research extending over more than twenty years, provides a notable addition to the literature of the Chalk zones. At the onset we must congratulate Mr. Brydone on the completion of the truly prodigious work of zoning 1,052 exposures of Chalk in Hampshire. He has succeeded, moreover, in producing from his results a very fine zonal map on the 1 inch scale, clearly a task beset with many difficulties.

Treatises on the Chalk of Hampshire, as Mr. Brydone remarks, are not numerous. On this account we could wish that in his brief bibliographical notes he had referred, as in a previous publication, to the excellent work on Chalk geology carried on since pre-zonal days by the Winchester College Natural History Society. Its latest publication [1] (issued since the appearance of Mr. Brydone's book), dealing with the various divisions of the Chalk, and giving lists of fossils and sketch-maps, affords a conspectus of the Chalk round Winchester that could not fail to be of great value to any student unable to consult more compendious essays. The present volume must be regarded as an amplification and completion of the previously published work by the author and Mr. Griffith on *The Zones of the Chalk in Hants.* As regards some views and terminology therein adopted, Mr. Brydone in his first chapter suggests sundry modifications. His researches have brought forward many interesting points in connexion with the *mucronata* zone, which, by the way, has been discovered in a new district near Dean. It is found that in Hampshire the ranges of *Belemnitella mucronata* and *Actinocamax quadratus* are commerged for at least 20 feet, the advent of the former coinciding with the appearance of marl. As Mr. Brydone says, "the general result is to administer . . . a severe shock to the doctrine of the infallibility of *B. mucronata* as a zonal guide."

Some changes are made with respect to the *quadratus* zone. It is proposed that the sub-zones of *Offaster pilula* and *Echinocorys scutatus*, var. *depressus*, should be separated under the name of the zone of *O. pilula*, but that this should still be divided into the sub-zones of abundant *O. pilula* and *E. scutatus*, var. *depressus*. The familiar *Rhynchonella cuvieri* has disappeared without apology or explanation from the zonal terminology in this book, *Inoceramus labiatus* being used instead as the index-fossil.

It may be highly desirable and may constitute an advance on the lines of present research to establish sub-zones (each in itself, of

[1] *Geological Notes on the Chalk of Hampshire, with Hints to Collectors*, by C. Griffith, M.A., F.G.S. 43 pp., with sketch-maps. Published by the Winchester College Natural History Society, 1912.

course, satisfying the definition of a zone), but original standardizations of zones should be retained. Nor does it seem desirable that any separate index-fossil should be invested with a denotation differing from that already generally accepted. Mr. Brydone is careful to define his terms, but it must be borne in mind that the arbitrary limitation of zones by successive workers tends to produce hopeless confusion in zonal nomenclature. And here it may be observed that only on the assumption that the boundaries of the author's zones differ from those given in previous publications on the Chalk is the difference in coloration in the map to be recommended.

One desirable feature of Mr. Brydone's work is the employment of a standard of values in referring to the occurrence of species by such terms as 'abundant', 'frequent', 'scarce', and so forth. Doubtless much ambiguity has from time to time been caused by the mode in which chance records have been interpreted and used as premises for more important generalizations. This attempt, therefore, at greater accuracy is to be welcomed.

A consideration of the general structure of the area dealt with occupies more than twelve pages; but extended reference to this section is obviously precluded here. In discussing his methods of mapping the author acknowledges the helpfulness of the work of the Survey in having traced the salient boundary-lines. One inherent difficulty in the author's undertaking was the lack of sections showing the complete thickness of zones. A brief but well-considered description of the locality of each exposure is given in a list, which groups the localities according to horizons, each exposure bearing a number corresponding to one on the map—a scheme that has been found advantageous in works with similar aims. For the reception of records not included in Messrs. Griffith & Brydone's book a supplementary table of fossils has been prepared. This table is prefaced by observations of which some seem to call for comment; and the author has done good service in abstaining from the use of specific names that have no definite meaning (e.g. *Serpula plana*). Mr. Brydone finds himself unable to see any justification for the record of *Micraster præcursor* as a separate species, a view that will come as a surprise to many Chalk workers. Such a point, in our present state of knowledge, must be a matter of opinion; but the fact remains that the group of *M. præcursor* as defined by Dr. Rowe is found very acceptable by workers in other parts of the country.

A chapter of palæontological notes is found at the end of the book. Here three new varieties of *Echinocorys scutatus* (vars. *elevatus*, *tectiformis*, and *cinctus*) are described, each occurring at a definite horizon. A sequence in the dominant shapes and sizes of *Offaster pilula* has been traced; and two new forms of *Bourgueticrinus* ('forms 6 and 7'), both of stratigraphic value, placed on record. The determination of these as auxiliary guides is extremely useful. Some attention has been bestowed upon Sponges, descriptions being furnished of four new species of *Porosphæra* and two of *Retispinopora* (new genus = *Spinopora* partim). *Plicatula hantonensis* is also among the new species described.

II.—The Moorlands of North-Eastern Yorkshire: their Natural History and Origin. By Frank Elgee, F.G.S. 8vo; pp. xvi, 361, with 70 plates and text-illustrations, geological maps and sections, and maps of the Moorlands. London: A. Brown and Sons, Ltd., 5 Farringdon Avenue, 1912. Price 12*s.* 6*d.* net.

VOLUMES, large and small, descriptive of the scenery and antiquities of various districts and counties in England, are by no means wanting, and the attractions of the Yorkshire Moorlands have been portrayed by many distinguished writers. The present work is, however, not merely descriptive, illustrated as it is by many excellent photographic plates by the author, with some by Mr. Godfrey Bingley; it is also explanatory, dealing with the geological history of the Moorlands, the disposition of the strata, and the sculpturing of the hills and dales, with the origin of the moors and distribution of their plant-life, and the relationship in general between the botanical, zoological, and geological features. In short, it is a philosophical work, treating the subject from what is now termed the Ecological point of view.

After referring to the previous literature on the district, the author gives a short account of some of the human aspects, describing the old roads, the ridgeways, the causeways (which are often paved with stone), the standing stones, circles, and crosses. Reference is made to pit-dwellings, some of which, however, like the Killing-pits near Goatland, were probably old ironstone workings, while some holes were evidently due to the removal of slabs of stone, and others have been caused by the dissolution of calcareous strata.

The highest ground in the Moorlands is at Burton Head on Urra Moor, 1,489 feet above sea-level. The moors are almost exclusively clothed with heather, but some are covered with much cotton sedge and grass. The author discusses the formation of the moorland soil, which comprises surface-peat, resting on about 10 inches of peaty sand, with usually at the base a hard ferruginous layer, generally not more than an inch or two thick, known as the Moor Pan. This layer has tended to prevent the growth of trees; so also have the strong winds on the higher and more exposed moorlands. Evidence of woods of oak and birch are, however, met with in some of the glacial slacks or overflow channels, where tree stumps are found beneath coverings of peat which destroyed the woodland. In some instances the destruction of the timber was probably accelerated by man. The vegetation on the moorland slopes differs from that on the summits, and the author points out that the aspect, inclination of slope, amount of downwash, and absence of thick peat, have influenced the distribution of the plants.

The effects of the Ice Age are duly considered with especial reference to the researches of Professor P. F. Kendall. The higher uplands afford no evidence of glaciation. The Cleveland Hills on the north presented an impassable barrier to the ice-sheets, so that sundry moors, though surrounded by ice, were free from any covering of it, and free therefore from drift. The author maintains the view that the driftless areas supported vegetation during the Ice Age, the plants

including most of the northern species. In discussing this subject he naturally refers to the labours of Mr. Clement Reid.

In the description of the geological formations, and the record of events which have led to the present physical features, the work of Mr. C. Fox Strangways is fully appreciated. It is pointed out that the wide moors could never have been evolved unless the strata were suitable, but the pure siliceous soils, which are mainly on the Estuarine Series, and to a less extent on the Kellaways and Corallian Beds, proved favourable to the growth of heather. There is a good view of the Cheese Stones at Baysdale, formed of Lower Estuarine Sandstones, which occasionally exhibit "atmospheric pot-holes", cavities that increase from mere depressions to two or three feet in diameter, and sometimes resemble fonts. They are attributed by the author to the action of the atmosphere, and of the wind acting on small fragments of rock. Hollows of this kind in other districts have been termed rock-basins.[1] The isolated rock-masses and most of the so-called boulders on the high moors are relics of strata in situ or not far removed; they have not been distributed by glacial action, but many have channels or grooves due to meteoric abrasion.

In giving short descriptions of the several formations the author notes the plants of the Oolitic coal-field, in which the moor coal occurs. The subject is illustrated by various views, those of the Kellaways Beds being fine examples. A plate of coloured geological sections indicates the general geological structure, and a very clearly printed geological map shows the distribution of the formations. The Cornbrash, which has but a narrow outcrop, is not separately coloured, but its position is pointed out (p. 192). Here it may be remarked that the geological map, while "based upon the Ordnance Survey Maps", is the product of the Geological Survey.

The author describes the main structural features, some due to the elevation and folding at the close of the Jurassic period and prior to the Cretaceous overlap. The covering of Chalk was removed in Eocene and Oligocene times, and it is regarded as probable that the features then produced belonged rather to a plain of marine denudation than to a subaerial peneplain, as the occurrence of scattered pebbles of flint and quartzite appears to indicate a former (possibly marine) Tertiary deposit. Disturbances accompanying uplift in Miocene times accentuated some of the earlier folds, and tilted the strata into their present positions. The author discusses the relation of the synclines and anticlines to the present features, including the formation of outliers and inliers. In describing the origin of the dales he points out that most of them lie outside the limits of glaciation, and are to be attributed to the ordinary action of rain, frost, snow, springs, and rivers, influenced by the dip and lithological characters of the strata.

The later portions of the volume contain accounts of animal life on the moors, and the author refers the mammalian remains of Kirkdale Cave to pre-Glacial times. This is not in accordance with evidence elsewhere, as in the older Thames Valley drifts, where the fauna is later Pleistocene; but it may be taken to mean that the remains are

[1] See D. Mackintosh, GEOL. MAG., 1867, p. 398.

pre-Glacial to the district. The final chapter contains a useful summary of the author's observations and conclusions, and it is followed by a good index.

III.—The Lost Towns of the Yorkshire Coast, and other chapters bearing upon the Geography of the District. By Thomas Sheppard, F.G.S. 8vo; pp. xviii, 329, with 156 illustrations. London: A. Brown and Sons, Ltd., 5 Farringdon Avenue, 1912. Price 7*s*. 6*d*. net.

THE particular portion of the Yorkshire coast described in the work before us is that of Holderness, which extends 35 miles between Bridlington and Spurn Head, and also includes the northern Humber shore westwards to Hull. These two tracts of coast, however, exhibit some conditions of a totally different character. Along the open sea-coast the average annual waste of land is 7 feet, or locally from 4 to 9 feet; while on the borders of the Humber, although there is evidence of the loss of a number of villages, large tracts of sediment have accumulated during a period of forty-five years, and more than two thousand acres have been reclaimed by means of embankments, and are now under cultivation. Indeed, the author remarks that "as years go on the Humber is confined to narrower and narrower channels".

In the more difficult task of estimating the amount of land which has been lost, the author, who is a keen observer, has made himself familiar with all the physical features and geological formations of the district, and with the processes of destruction of the cliffs. He has, moreover, had the benefit of a number of cliff-measurements, and of consulting documents, plans, and charts, many of which have not previously been studied in connexion with the waste of the land. He has therefore been able to deal more fully and precisely than others have done with the results of the coast erosion, and his work is profusely illustrated with maps, plans, charts, pictorial views of the coast, reproductions of old engravings of lost churches and other buildings, and objects of archæological interest.

A brief and to some extent hardly necessary account is given of the geological formations of the Yorkshire coast, from the Lias to the Chalk and Drifts, as the Drifts alone are of importance in reference to the physical features of Holderness and to the nature of the cliffs. The land, which includes considerable areas below sea-level, is formed in part of Alluvium, but mostly of red or purple Boulder-clay. It is a low-lying hummocky tract of clay and gravel, in which formerly there were many meres, but only that of Hornsea remains.

The sea-cliffs, 10–50 feet high, are thus formed mainly of clayey material which is readily eroded, the various subaerial forces acting with the sea in the processes of waste. A view of the cliffs at Kilnsea shows the way in which the sea is assisted in its work of destruction by the drains leading to the cliff-edge and softening the clay.

Apart from the visible waste, it has been pointed out that much erosion is going on below low-water level, many miles out to sea, and at depths of from 5 to 10 fathoms. It is estimated that since

Roman times about 83 square miles of land have been lost, equal to a strip 2½ miles in width along the Holderness sea-coast.

The author describes the changes that have taken place in the neighbourhood of Hull, and points out that the once flourishing seaport of Hedon, to the east, is now 2 miles distant from the Humber. To the south-east the large tract of Sunk Island and bordering ground have been reclaimed, but a number of villages have been lost between that island and Spurn Head. Full particulars are given of these and other lost villages and towns along the Holderness shores. The author then briefly describes the origin of the Humber mud, the natural history of the district, and the extinct animals, including the Mammoth and others among those pre-Glacial in the area. The early and later history of the people and their works, the administration, agriculture and other industries receive attention, and finally there are notes on the climate and rainfall. A good index completes this able record of the natural and artificial changes that have taken place in the district.

IV.—Soils and Substrata.

The Geology of Soils and Substrata, with Special Reference to Agriculture, Estates, and Sanitation. By Horace B. Woodward, F.R.S., F.G.S. 8vo; pp. xvi, 366, illust. London: Edward Arnold, 1912. Price 7*s.* 6*d.* net.

THIS is exactly the sort of book one is always wanting, and it could scarcely have proceeded from the hands of one more competent than Mr. Woodward. It is not a book to criticize, but to describe, and we content ourselves by offering to our readers a sketch of the various points treated.

After a preliminary outline of geology, the relations of rocks to the form of the ground and scenic geology in general, the value of geological maps, and the advantages of such knowledge in agricultural research are pointed out, and definitions of subsoils and substrata are given. The author then treats of weathering, subsidence, surface-soils, and climatic and other physical conditions affecting the soils and agricultural operations. Passing on to chemical and mechanical constituents of soils, plant foods, and bacteria, he discusses the fertility and barrenness of soils, drainage and irrigation, water meadows and manures, dealing especially with forests, woodlands, orchards, market gardens, and vineyards. Geological considerations concerning estates, mineral rights and economic materials, sites for buildings, disposal of waste water, farm drainage and refuse, sewage farms, cemeteries, water supply, and ponds, are all dealt with in turn, and the remaining chapters are devoted to sketches of the various geological formations met with in England and Wales.

The subject is dealt with from the practical point of view. Under the term 'soils' are included the subsoils and surface-soils, the term 'substrata' being, for the sake of convenience, applied to the igneous as well as to the various sedimentary and metamorphic formations from which the mineral constituents of the soils are directly or indirectly derived. Prominence is therefore given to the

chief mineral and lithological characters of the formations and to their economic products, little being said about their method of origin, and less about their life-history.

This book should be found of great service to farmers, builders, and estate agents, and its value is considerably enhanced by the numerous references to the more advanced and special literature on the various subjects, and the excellent index.

V.—The Distribution and Origin of Life in America. By Robert Francis Scharff, Ph.D., B.Sc. 8vo; pp. viii, 497, with 20 figures [maps]. London: Constable & Co., Ltd., 1911.

FOLLOWING on the delivery in London of the "Swiney Lectures on Geology" five years ago, Dr. Scharff published the now well-known *History of the European Fauna*. The present volume contains the substance of his second series of lectures on the "Geological History of the American Fauna", but the subject-matter has been amplified and enlarged. It should be mentioned that owing to unusual circumstances notice of this valuable book has been somewhat delayed.

Each one of Dr. Scharff's fifteen chapters deals with a separate region, e.g. Greenland, north-eastern North America. The wealth of information contained in this book, which is furnished with twenty helpful maps, is conveyed in an interesting fashion; and reference to the numerous authorities quoted throughout the book is made in a fairly complete bibliography at the end.

As might be expected, the problems connected with the Ice Age form an important part of this book. There is ample biological evidence now available to show that the formation of two land bridges, connecting North America with Europe on the east, and Asia on the west, closed in the Pacific and Atlantic Oceans on the north about the same time. Hence the warmer climate in Pre-Glacial times must be attributed to the fact that the Arctic Ocean received more abundant warm currents then than now. The idea of a former land-connexion joining Scotland, Iceland, Greenland, and Labrador, put forward on several independent grounds, has its strongest confirmation, Dr. Scharff thinks, in the geographical distribution of *Helix hortensis*, a typically West European species. This snail has been found in the mainland of Europe, Ireland, Shetland, the Faröes, Iceland, South Greenland, Labrador, the islands off the north-west coast of North America, and part of the opposite mainland; and it has lately been collected from the Pleistocene of Maine. That geological evidence as to the date of this land-connexion will ever be forthcoming seems far from probable.

Among other instances of former land-connexions adduced in discussing the distribution of various animals are the mid-Atlantic, the South Atlantic, and the North Pacific. The account of the fauna of the Galapagos Islands is particularly interesting and important. The author inclines to the view of Professor Baur that this archipelago represents the remnants of a sunken land-mass once uniting the West Indies, Cocos Island, and Central America, and is not, as Darwin held, of volcanic origin.

In this book, however, we find so vast an amount of detail that a consideration of its full merits is not feasible in the space at our disposal. It remains only to add that the volume must at once take its place as a standard work of reference.

VI.—Geological Survey of Scotland.

The Oil-Shales of the Lothians. Part I: The Geology of the Oil-Shale Fields. By R. G. Carruthers, based on the work of H. M. Cadell and J. S. Grant Wilson.—Part II: Methods of working the Oil-Shales. By W. Caldwell.—Part III: The Chemistry of the Oil-Shales. By D. R. Steuart. Second edition. pp. xii, 199, with 83 text-illustrations and 3 plates. Printed for His Majesty's Stationery Office, 1912. Price 2*s.* 6*d.*

THE former edition of this work was published in 1906; and that the public appreciate a memoir having important practical applications is shown by the issue of a revised edition. Owing to the death of Mr. Grant Wilson the geological part of the memoir has been revised by Mr. Carruthers, who has added much new information relating to the later boring operations and the extensive mining developments.

The Oil-shale Group occurs in the Calciferous Sandstone Series, and includes six important seams of oil-shale, interstratified with beds of sandstone, shale, fireclay, marl, and estuarine limestones. The Oil-shale Group, more than 3,000 feet in thickness, forms the upper division of the Calciferous Sandstone Series; the lower or Cementstone Group has not at present yielded any oil-shales. The distribution of the strata is well shown on a colour-printed geological map, on the scale of an inch to two miles.

Among some of the new points to which attention is directed, are the separation of the Barracks and Burdiehouse Limestones; the recognition of the zonal value of certain horizons, especially two bands of marine fossils, the Mungle and Pumpherston shell beds, which have been proved to extend over the whole oil-shale field; and the demonstration that the teschenite sills are generally restricted to particular horizons, while the quartz-dolerite sheets are more irregular in their occurrence. A plate showing the most characteristic fossils has been added, together with notes dealing with their value to the mining engineers. Most of the longitudinal sections have been re-drawn and some new ones inserted, while the plate of vertical sections has been revised.

The accounts of the mining and manufacturing processes have been brought up to date by Messrs. Caldwell and Steuart. The products include naphtha, various oils, paraffin, grease, still coke, and sulphate of ammonia (for manure).

VII. Bulletins of the United States Geological Survey.—In this memoir, No. 492, Dr. G. F. Loughlin discusses fully the gabbros and associated rocks, covering a quadrangular area of about 102 square miles, at Preston in the eastern crystalline rocks of Connecticut. The

rocks in question comprise one complex of metamorphic sedimentaries —quartzite, quartz-biotite schist, hornblende-schist, black pseudo-porphyritic schist, of the type to which Fischer gave the name of kinzigite in 1861, and dolomite, two intrusive igneous masses—the Preston gabbro and the Sterling granite gneiss, and the great Lantern Hill quartz, which is one of the largest quartz masses known, being 1¾ miles in length and more than 1,000 feet in maximum width. The nature of the folding and the metamorphic deformation is carefully considered. The Preston gabbro has two principal variations: (1) a coarse porphyritic rock with large poikilitic phenocrysts of diallage, and (2) a quartz-hornblende gabbro, the former constituting the greater part of the area. The paper is amply illustrated with maps and micro-photographs.

In Bulletin 509 of the United States Geological Survey Mr. Waldemar T. Schaller brings together a number of interesting mineralogical studies which have mostly appeared elsewhere. He suggests that the variability in the composition of the members of the rutile group is readily explained by the assumption that the group is an isomorphous mixture of rutile, TiO_2, cassiterite, SnO_2, and tapiolite, $FeO . Ta_2O_5$, and proposes to retain the term ilmeno-rutile to designate mixtures in which Fe, Ta, Cb, and Ti are present in quantity, but to reject such variety names as mossite, iserite, ainalite, and struverite. An examination of crystallized turquoise from Virginia showed the mineral to be isomorphous with chalcosiderite, and, since the formula obtained for the former was $CuOH . 6[Al(OH)_2] . H_5 . (PO_4)_4$, that of the latter should be $CuOH . 6[Fe(OH)_2] . H_5 . (PO_4)_4$. Crystallized variscite from Utah was found to correspond in composition to the formula $Al_2O_3 . P_2O_5 . 4H_2O$, and in physical characters to be similar to scorodite and strengite. Apropos of the new hydrous sulphate and phosphate of lead, hinsdalite, the relationships of the alunite-beudantite series were discussed. An investigation of minerals from Beaver County, Utah, brought to light a new hydrous sulphate of lead and copper, beaverite, which is related to no known mineral. A description is given of a curious new mercuric mineral allied to kleinite.

VIII. Mines' Department, Canada.—The Summary Report for the calendar year ended December 31, 1912, shows increasing activity in the work of this Department, and we understand that the annual programmes are arranged with the principal object of rendering practical public service in the interests of the country. This volume contains the usual synopses of investigations, as well as the chemical, statistical, and essay reports, and statements from the Fuel-testing Station and the Metallurgical Laboratory. The investigations connected with the Canadian peat fuel industry are now almost complete, and have already been successful in their aims; and the establishment of a metallurgical research laboratory is of great practical importance to the department.

Among the preliminary reports on field-work may be mentioned those on the building-stones of the Maritime Provinces, the nickel

industry (with special reference to the Sudbury region), and copper In the Sudbury nickel-field an experimental magnetometric survey was made, and the results show the magnetometer to be of signal assistance in such work. There are two appendices to the volume, one being a preliminary report on the mineral production of Canada for 1911, and the second an account of the explosive industry. A magnetometric map of a small area in the Sudbury nickel district and plans of the new headquarters of the Mines Branch are included among the illustrations.

From the same Department we have received also a detailed statistical report (145 pp., 10 plates, and numerous illustrations) on the utilization of peat fuel for the production of power. This is a record of experiments conducted at the Fuel-testing Station, Ottawa, 1910–11, and is divided into two parts: first, a description of the Körting producer-gas plant and cleaning system, with complete detailed records of trials and tests; secondly, a description of the alterations made to the plant, with similar records taken after alteration.

IX. University of California Publications.—From the Geological Department of this University we have received Bulletins 6–8 of vol. vii. Bulletin 6 is by Mr. C. L. Baker, on the physiography and structure of the Western El Paso Range and the Southern Sierra Nevada. The observations were made during a collecting reconnaissance for vertebrate fossils, and therefore do not aim at completeness. A sketch of the geography of the El Paso Range is given, and the rocks are seen to consist of a basement complex of metamorphic and plutonic rocks, a superjacent series of sedimentary and volcanic rocks, and the alluvium. The Ricardo erosion surface of the Southern Sierra Nevada is described, and it is seen that the southern Sierra front has not shared in the uplift that affected the country to the east and west.

A discussion by Mr. Bruce Martin on the fauna of the type locality of the Monterey Series in California occupies Bulletin 7. Details of location, stratigraphy, and lithology are given, and the various members of the fauna considered; and the general results support the correlation of the beds of the type locality with the middle and lower portion of Monterey Miocene of San Pablo Bay.

In the eighth Bulletin Mr. L. Kellogg describes the Pleistocene rodents from the Pollen Creek and Samwell Caves, and from the asphalt deposits at Rancho La Brea, near Los Angeles. These rodents are very persistent, for while they belong to genera still living, some of the carnivores and ungulates found with them are of genera now extinct. The rodent fauna of the caves does not accord with the present topography of the region, but that of the asphalt deposits is near to the existing fauna of the region and belongs to the Upper Sonoran zone. Two new sub-species are described: *Sciurus griseus fossilis* from the Samwell Cave and *Citellus beecheyi captus* from Rancho La Brea.

X.—Desert Conditions Past and Present.

Das Gesetz der Wüstenbildung in Gegenwart und Vorzeit. By Johannes Walther. pp. xv + 342, with 147 illustrations in the text. Leipzig: Quelle & Meyer, 1912. Price 12 marks.

AMONG those who have studied and described the characters of desert regions and have thrown light upon the conditions which prescribe their formation, Professor Walther occupies a prominent position. The volume which he issued in 1900 on the subject immediately attracted wide attention and some little controversy. With the publication of that work, however, his interest in the subject in no way waned, neither was his energy exhausted, and whenever time and opportunity afforded he seems to have found his way to Egypt and to have continued his observations and researches. The outcome is this, the second, edition, which represents the fruits of an almost continuous study of the subject for a quarter of a century. Written in an admirably easy style and amply illustrated with reproductions of excellent photographs, the book cannot fail to prove of extreme fascination and absorbing interest, not only to students of the subject, but to any reader with sufficient knowledge of the language to be able to read the book without difficulty.

The book is divided into four main sections. In the first is given a description of the desert regions as they exist to-day, and the effect produced by extreme heat and rapid evaporation is vividly brought home to the reader. In the next the author describes the erosion produced by the action of wind and sand, and by the torrential cloud-bursts which occasionally occur; the effect of weathering is very clearly visible in the case of the statues remaining in some of the ruined temples in Egypt. In the third section the author considers the formation and nature of the deposits which have resulted from the actions described in the previous section; and in the fourth and last he discusses the deserts of past ages, which have resulted in the immense beds of rock-salt and gypsum, containing the relics of a marine fauna, poor in species, but rich in individuals, found in various parts of the world. The value of the book is increased by the list of references and the complete index given at the end.

XI. The Dover Coal-field.—In the Geological Magazine for April, 1890 (p. 192), we announced, on the authority of Professor W. Boyd Dawkins, the discovery of coal in the boring at the foot of Shakespeare's Cliff. We read in the *Daily Mail* of February 4, 1913, that "coal from Snowdown Colliery, between Dover and Canterbury, was yesterday put on the local market by coal-dealers at prices slightly below those of imported coal. This is the first Kentish coal to be publicly marketed". The colliery is close to the Fredville boring and about 7 miles south-east of Canterbury.

It is interesting to receive at the same time an article on "The South-Eastern Coal-field, the Associated Rocks, and the Buried Plateau", by Professor Dawkins (Trans. Inst. Mining Eng., xliv, pt. ii, p. 350, 1913). He gives a plate, with three maps and two longitudinal sections, to show (1) the area of the South-Eastern

Coal-field, which extends from Dover to Deal, Wingham, and near to Ebbsfleet; (2) the structure of the ground between the borings at Dover and Ropersole, and between those of Fredville and Brabourne; (3) a map of the buried Silurian and Devonian rocks in South-Eastern England; and (4) a map of the coal-fields and tectonic folds of Southern England and Wales. He discusses the general structure of this southern area, and then gives details of the experimental borings, some of which proved the absence of Coal-measures, as at Chilham, in the valley of the Stour above Canterbury, and at Bobbing, near Sittingbourne, where Silurian rocks were found directly beneath Jurassic strata. Some lists of fossils are given, and the author recommends that further trials for Coal-measures should be made in the district south of Croydon.

XII.—Brief Notices.

1. Geology of Victoria and Tasmania.—Mr. Frederick Chapman has contributed Reports on the Middle Devonian fossils of the Buchan district and on the Silurian and Devonian fossils of the Mitta Mitta district, Victoria (Records Geol. Survey, Victoria, vol. iii, pt. ii, 1912). Among the Middle Devonian fossils of Buchan are *Favosites basaltica*, Goldf., var. *moonbiensis*, Eth. fil., *Conocardium*, *Murchisonia*, and *Cheirurus* (?). The age of the fossils of Mitta Mitta cannot be so definitely determined; some may be Silurian, others, including *Cyathophyllum* and *Favosites*, are probably Devonian. To the same publication Mr. Chapman supplies a note on the correlation, by means of plants, of the Tasmanian and Victorian Jurassic strata. He has also recently paid special attention to the Phyllocarida, which seem to occur fairly abundantly in the Ordovician Shales of the colony, and *Hymenocaris hepburnensis* is described as new. Some well-preserved specimens of *Haliserites dechenianus*, Goepp., have likewise been figured and described by Mr. Chapman, who in the same volume gives an illustrated description of the fossil scale of a *Ceratodus* from the Jurassic beds of Kirrak, South Gippsland, calling attention to the interesting point that this is the first occurrence of a fossil scale of the fish.

2. *Sphenophyllum* in Australia.—In a report on the Mount Mulligan Coal-field (Geol. Surv. Queensland, 1912, publ. 237, p. 11), Mr. Lionel C. Ball reports the discovery in the shales of Siberia Camp of the pteridophyte *Sphenophyllum speciosum* in association with *Glossopteris*. The single individual obtained is described and figured. Hitherto Australia has yielded only a single very imperfect specimen of *Sphenophyllum*, which came from the Lower Carboniferous beds of Port Stephens, N.S.W. The finding in Northern Queensland of *S. speciosum*, which is characteristic of the Lower Gondwana beds of India, is of great interest as affording another link in the chain of evidence connecting Australia, India, and South Africa in Permo-Carboniferous times, by way of the sunken continent Gondwana-land. Figures of *Glossopteris*, *Sphenophyllum*, and *Sphenopteris* are given in support of the age of the beds, as well as sections, maps, and illustrations.

3. Queensland, Department of Mines.—Among other interesting reports recently issued W. E. Cameron deals with the coals of North Ipswich and Dalby, gold at Ormeau, tin-lodes of the Charters Towers district, and olivines in the Toowoomba Basalts. These latter are of so fine a size and colour as to recommend themselves to European cutters for a market of 100 ounces per week. E. O. Marks deals with the *Glossopteris* flora near Hughenden and Pentland, coal near Chinchilla, and gold at Mount Emu Plains and Cape River.

4. Wyoming Geology.—An account by Mr. C. E. Jamison, of the Douglas Oil-field, Converse County, Wyoming, is contained in Bulletin 3, Series B, of the Report of the Wyoming State Geologist, 1912. The location of the fields, which are drained by tributaries of the Platte River, is discussed, and a sketch of the topography of the area is accompanied by a useful map. The geology is rather difficult, because Tertiary beds mask the Triassic, Jurassic, and Cretaceous rocks, and faulting causes further complications. Details of formations are arranged in a convenient table, and the various systems with their fossils are briefly discussed. A list of wells is accompanied by descriptive notes, and information under the heading "future development" is likely to be of value. The Muddy Creek Oil-field, in Carbon County, is similarly treated, and the bulletin is illustrated by eight plates.

5. Mining in Elko County, Nevada.—Mr. E. C. Schrader gives in Bulletin 497 of the United States Geological Survey a full account of the physical and geological characters of the important mining region which has in recent years been developed in Elko County, Nevada. It lies in an area of folded and tilted Palæozoic sedimentary rocks cut by granular intrusives and flooded by Tertiary lavas, principally rhyolite. At Jarbridge the mineral deposits occur chiefly as tabular, gold-bearing fissure veins and lodes in rhyolite, an interesting feature being the exceptional abundance of adularia. There appear to have been two distinct periods of mineralization, calcite and barytes being first formed and afterwards silicified by the rising of thermal solutions. At Contact and Elk Mountain the ore is mainly copper, but a little silver and gold are also present. The paper is well illustrated with maps and photographs, and is supplied with a good index.

6. Iron Ores of Tennessee.—Mr. R. P. Jarvis gives an account of "The Valley and Mountain Iron Ores of East Tennessee" (*Resources of Tennessee*, vol. ii. p. 326, 1912). Magnetite occurs in the Cranberry granite, and its occurrence is attributed to segregation from the gabbro dykes. Bedded deposits and pockets of brown and red hæmatite occur in association with Cambrian, Ordovician, and Silurian formations. The yield in 1910 of red hæmatite was 301,838 tons, and of brown hæmatite 430,409 tons.

7. Rhodesia.—From the Tenth Annual Report of the Rhodesia Museum for 1911 we learn that the rocks are arranged, the labelling of the mineral collection is getting towards completion, and that the palæontological series is to be displayed at an early date. Good collections of tinstone-bearing greisens and fine cassiterites are at present on loan.

8. Permian of Durham.—Dr. Woolacott's paper, printed in abstract only by the Geological Society of London in 1911, has now appeared in full in the Proc. Univ. Durham Phil. Soc., vol. iv (5), 1912. It runs to seventy pages, is well illustrated, and issued at half a crown, so should be useful to many geologists. Attention may be directed to several excellent photographs showing weathering of the local rocks.

9. The Hamada Country.—Under this title we welcome a short paper on a part of Sinai by G. W. Murray, the son of our late colleague, G. R. M. Murray, of the British Museum. The district contains the Sinaitic minerals, copper, turquoise, manganese, iron and petroleum, and a good series of Carboniferous rocks. It is also much broken by a series of titanic faults, one of which has a throw of 1,320 metres. The paper is illustrated by photographs and a well-printed coloured geological map. It appeared in the *Cairo Scientific Journal*, vol. vi (No. 74), pp. 264–73, November, 1912. The paper is frankly of a general nature, but contains many valuable geological notes.

10. Duddon Estuary.—Those interested in J. F. N. Green's paper on this area which was read before the Geological Society of London on March 27, 1912, and published by the Society in the Abstract of Proceedings, 1911–12, p. 71, will be glad to hear that the whole paper has now been privately printed by Mr. Green and is available for reading and consideration.

11. Microscopical Petrography.—Dr. F. E. Wright contributes to the *Journal of Geology* for September–October, 1912, a paper on microscopical petrography from the quantitative viewpoint, in which he emphasizes the fact, not always realized by petrographers, that the quality of the quantitative work is far more important than the quantity of the qualitative work, and reproduces the main features of his discussion and description of the most refined methods of microscopic research published by the Carnegie Institution of Washington.

REPORTS AND PROCEEDINGS.

I.—Mineralogical Society.

January 21, 1913.—Dr. A. E. H. Tutton, F.R.S., President, in the Chair.

T. V. Barker and J. E. Marsh: Optical Activity and Enantiomorphism of Molecular and Crystal Structure. The general nature of enantiomorphous structures accompanying optical activity in the liquid and crystalline conditions was discussed, and it was pointed out that, since the optical activity observed in crystals of six substances, including epsomite and sodium chlorate, cannot be referred to the crystal structure, it must be due to an enantiomorphous configuration of the atoms within the molecule. Suitable enantiomorphous configurations have been deduced on chemical grounds, the constitution of the compounds being based on a modification of Werner's theory of

co-ordination. The symmetry of the new spatial formulæ is in many cases identical with the symmetry, and, in particular, sodium nitrate can best be regarded as a racemate due to a mutual interpenetration of optical antipodes having spatial configurations similar to those suggested for the active forms of sodium chlorate, the symmetry of the double molecule being identical with that of a rhombohedron. The same type of molecular structure presumably exists in calcite and the rhombohedral form of sodium chlorate which crystallizes at high temperatures. It is concluded that many cases of dimorphism are of an analogous character, and, more generally, that polymorphous change is preceded by a re-arrangement of the atoms within the molecule.—H. Collingridge: Note on the Determination of the Optic Axial Angle of Crystals in Thin-section. In the case where one optic axis is visible in the field of view, the position of the second axis may be determined more conveniently than in the Becke and Wright methods from the optic axial plane and the extinction direction through the centre of the field.—Dr. G. F. H. Smith: Graphical Determinations of Angles and Indices in Zones. Two methods were described, which, unlike the moriogram, are not restricted to right-angled zones. In one a double tangent scale is placed on a pencil of lines spaced as in a gnomonic projection on a zonal plane in such a way that the 01 and 11 lines cross the scale at the given angles; the angles corresponding to any indices, or vice versa, are read off directly within the limits of the scale. In the second method a double diagram is employed, of which one half is a new form of the moriogram and the other is a representation of angles whose cotangent is the difference of the cotangents of the given angles; the method is general and unrestricted in its application.—Dr. J. Drugman: On the Goldschmidt Apparatus for Cutting Models of Crystals. The mechanism was described, and the method of using it explained.—Professor H. L. Bowman: On a Nodule of Iron Pyrites. The octahedral shape and the striations on the faces truncating the coigns of the tiny crystals point to their being pyrites, and not marcasite as usually stated.—A Chinese bowl carved out of an amethyst geode, and a set of scales and weights used by the native jewellers in India for weighing pearls, were exhibited by F. N. A. Fleischmann and E. Hopkins respectively.

II.—Geological Society of London.

January 22, 1913.—Dr. Aubrey Strahan, F.R.S., President, in the Chair.

The following communications were read:—

1. "The Fossil Flora of the Cleveland District of Yorkshire. I. The Flora of the Marske Quarry." By H. Hamshaw Thomas, M.A., F.G.S. With Notes on the Stratigraphy by the Rev. George John Lane, F.G.S.

In this paper the author describes several plants collected by the Rev. G. J. Lane and Mr. T. W. Saunders in the Cleveland district of

Yorkshire, which were sent to Cambridge for examination. Other specimens described were obtained by the author from the Marske Quarry and by the late Mr. Hawell, whose collection is now in the Dorman Memorial Museum, Middlesbrough.

The following species are dealt with: *Equisetites columnaris*, Brongn., *Sagenopteris phillipsi* (Brongn.), var. *major*, Sew., *Laccopteris polypodioides*, Brongn., *Dictyophyllum rugosum*, L. & H., *Stachypteris halleri*, a new type recently described by the author, *Coniopteris hymenophylloides*, Brongn., and *C. quinqueloba* (Phill.), *Todites williamsoni* (Brongn.), *Cladophlebis denticulata*, Brongn., a new species of *Marattiopsis* (a genus not hitherto recorded from Yorkshire), *Williamsonia spectabilis*, Nath. (microsporophylls of which were found by the author, throwing additional light on this type of flower), *W. whitbiensis*, Nath., and a female strobilus identified as *W.* sp., *Zamites* (*Williamsonia*) *gigas*, L. & H., *Psilophyllum* (*W.*) *pecten* (Phill.), *Tæniopteris vittata*, Brongn., *T. major*, L. & H., *T.* sp., *Wielandiella nilssoni* (Phill.), formerly known as *Anomozamites nilssoni*, *Otozamites feistmanteli*, Zigno, *O. graphicus* (Leck. *ex* Bean MS.), *Dictyozamites hawelli*, Sew., a Cycadean stem classified as *Wielandiella* sp., *Nilssonia mediana* (Leck. *ex* Bean MS.), *N. orientalis*, Heer, a new species of *Pseudoctenis* (a genus recently founded on specimens of Cycadean fronds from the Upper Jurassic of Sutherland), *Ginkgo digitata* (Brongn.), *Baieria longifolia* (Pomel), *Czehanowskia murrayana* (L. & H.), *Elatides setosa* (Phill.), and *Taxites zamioides* (Leck. *ex* Bean MS.).

The Marske flora, which includes several types not hitherto recorded from the Jurassic plant-beds of Yorkshire, is believed to be of Middle Jurassic age; specimens previously identified as *Zamites buchianus* (Ett.) and *Nilssonia schaumbergensis* (Dunk.), Wealden species, are described respectively as a new species of *Pseudoctenis* and *Nilssonia orientalis*, Heer.

A note is appended by the Rev. G. J. Lane on the stratigraphy of the Marske Quarry, situated on the northern face of the Upleatham outlier, about a mile distant from Marske-by-the-Sea. The Marske beds are assigned to the Lower Estuarine Series.

2. "The Derived Cephalopoda of the Holderness Drift." By Charles Thompson, B.Sc. (Communicated by G. W. Lamplugh, F.R.S., F.G.S.)

Although it has been known for a century that the Drift of Holderness is rich in derived fossils, for many years the collecting of them was neglected. However, in recent years collections of the Cephalopoda have been made, and it is now claimed that about 180 species of Ammonites are already in hand from the Glacial Drift. There are two important points about these specimens: the one, that a large number are new to Yorkshire lists hitherto published; the other, that the matrix of many of them cannot be matched now by our land exposures. It remains to consider whence they came.

The whole of the Lower Lias is so well represented by all its genera, and the rocky matrices are so characteristic, that it is urged

that the ice plucked them from outcrops in the bed of a former North Sea; also that these outcrops show the continuity of the North Yorkshire Basin with that of North-Western Germany. The list appended to the paper supports this statement, for it shows that many gaps are now filled, which are obvious when Hyatt's lists for the two regions are compared.

The Middle and the Upper Lias afford much material, but the types are closer to those of North Yorkshire. The Oolites are very scantily represented, although the Lower Cretaceous is abundantly represented both by Ammonites and by Belemnites. Again, there is a great difference between the state of preservation of a collection made from the Drift and that of one which can be made now from the Speeton Clay in situ. Hence, the existence of a wide spread of these clays to the east is confirmed.

The Chalk Belemnites belong to a zone higher than any known in Yorkshire; therefore they probably came from the sea-bed.

CORRESPONDENCE.

FOSSIL BEADS (?) FROM THE GRAVEL OF BEDFORDSHIRE. ARE THEY EVIDENCE OF HUMAN WORKMANSHIP?

Sir,—As I was searching in a gravel-pit some few weeks ago one of the workmen brought me some very curious beads, which I enclose to you. They lay in various positions in the gravel, and were not all in one place, but scattered about in different parts of the pit, and they varied in size from that of a large marble to that of a pea. The supposition is that they are sponges, but possibly some of them may have been artificially fashioned and drilled for stringing. Advantage may have been taken in the case of the others of a natural perforation formed by the decay of the nucleus round which the sponge was formed, and the hole enlarged by one of those flint-borers which are often found, to admit of stringing on a sinew or a strip of hide. I am told that Palæolithic implements have been found in this pit, though I was not so fortunate as to find any. May I not pertinently ask, does not the occurrence of these beads point to a higher state of development in Palæolithic man than is generally conceded? Indications are not wanting which strongly support this view. Witness the cave-paintings of Altamira in Spain, and the occurrence of highly worked Palæolithic implements in caves of Aurignacian age in France, and lately of similar flints at Duston, Northants. While on this subject may I ask why there should not have been in Palæolithic times men of different stages of development living in different parts of the world as at the present day? The tendency has been to class all these ancient races as under the same degree and state of development. It is probably in southern regions where the earliest traces of the higher-developed Palæolithic man are to be found, climatic conditions in the north in those early times being less favourable to their development, if not precluding their existence altogether. I may say

that the locality is Willington, Bedfordshire, and the formation river-gravel.

J. T. Banton.

Kingston Rectory, Cambridge.
January 18, 1913.

P.S.—The Rev. O. Fisher M.A., F.G.S., and Professor J. E. Marr, Sc.D., F.R.S., who have seen the beads, both support the view of their having been used as personal ornaments. They are often, though by no means always, perforated naturally. There is strong reason for supposing they have been used as beads.—J. T. B.

Note by the Editor on the so-called 'Fossil Beads'.

In reply to Mr. J. T. Banton's letter it may interest some of our readers to learn that the so-called fossil beads were figured by Dr. G. A. Mantell in his *Geology of Sussex* in 1822 from the Chalk near Brighton; and in 1829 by Professor J. Phillips in *Geology of Yorkshire*. In 1833 Samuel Woodward in his *Outlines of the Geology of Norfolk* figured several examples from Norwich and from Holt as *Millepora globularis* (now known as *Porosphæra globularis*, Phillips, sp., a small globular species of Calcisponge from the Chalk of England and the Continent). Their history is very extensive, and has been most carefully set forth by Dr. G. J. Hinde, F.R.S. (see Journ. Roy. Micro. Soc., 1904, pt. i, pp. 1–25, pls. i and ii), who describes and figures six species.

In Mr. James Wyatt's paper in the *Geologist* (vol. v, pp. 233–5, 1862) the writer says he first became acquainted with these objects about fifteen years earlier (1847) when uncovering some Anglo-Saxon remains in the Kempston gravel-pit, near Bedford, when several round stones perforated were met with; he adds, "so strongly was I impressed at the time that they were the personal ornaments of the ancient chieftain just exhumed that I actually presented them to the Archæological Society as Saxon beads . . . Subsequent examination of the Drift gravels convinced me that the balls were of an earlier period than the Anglo-Saxon, whether works of art or natural productions. They are described by naturalists as specimens of the Chalk fossil *Coscinopora globularis*, but the question is, how did they become perforated?" Mr. Wyatt, after having examined a great number of specimens, concludes the perforation in these small globular bodies to be *artificial*. In this opinion he was supported by Dr. Rigollot,[1] who wrote that "les petites boules avaient servi à former des colliers à l'usage des peuple sauvages"; but subsequently a strong objection was taken to this opinion by M. Albert Gaudry, who[2] denies that there is any evidence for the assertion that these are works of art, and asserts that they are found *in the Chalk* perforated in the same manner as those specimens found in the Drift.

[1] See account of Dr. Rigollot's observations (*Mémoire sur les instruments en silex*, etc., p. 16, Amiens, 1854). See also Lyell's *Antiquity of Man*, 4th ed., 1873, pp. 165–6, fig. 22.

[2] Trans. Inst. France.

that the ice plucked them from outcrops in the bed of a former North Sea; also that these outcrops show the continuity of the North Yorkshire Basin with that of North-Western Germany. The list appended to the paper supports this statement, for it shows that many gaps are now filled, which are obvious when Hyatt's lists for the two regions are compared.

The Middle and the Upper Lias afford much material, but the types are closer to those of North Yorkshire. The Oolites are very scantily represented, although the Lower Cretaceous is abundantly represented both by Ammonites and by Belemnites. Again, there is a great difference between the state of preservation of a collection made from the Drift and that of one which can be made now from the Speeton Clay in situ. Hence, the existence of a wide spread of these clays to the east is confirmed.

The Chalk Belemnites belong to a zone higher than any known in Yorkshire; therefore they probably came from the sea-bed.

CORRESPONDENCE.

FOSSIL BEADS (?) FROM THE GRAVEL OF BEDFORDSHIRE. ARE THEY EVIDENCE OF HUMAN WORKMANSHIP?

Sir,—As I was searching in a gravel-pit some few weeks ago one of the workmen brought me some very curious beads, which I enclose to you. They lay in various positions in the gravel, and were not all in one place, but scattered about in different parts of the pit, and they varied in size from that of a large marble to that of a pea. The supposition is that they are sponges, but possibly some of them may have been artificially fashioned and drilled for stringing. Advantage may have been taken in the case of the others of a natural perforation formed by the decay of the nucleus round which the sponge was formed, and the hole enlarged by one of those flint-borers which are often found, to admit of stringing on a sinew or a strip of hide. I am told that Palæolithic implements have been found in this pit, though I was not so fortunate as to find any. May I not pertinently ask, does not the occurrence of these beads point to a higher state of development in Palæolithic man than is generally conceded? Indications are not wanting which strongly support this view. Witness the cave-paintings of Altamira in Spain, and the occurrence of highly worked Palæolithic implements in caves of Aurignacian age in France, and lately of similar flints at Duston, Northants. While on this subject may I ask why there should not have been in Palæolithic times men of different stages of development living in different parts of the world as at the present day? The tendency has been to class all these ancient races as under the same degree and state of development. It is probably in southern regions where the earliest traces of the higher-developed Palæolithic man are to be found, climatic conditions in the north in those early times being less favourable to their development, if not precluding their existence altogether. I may say

that the locality is Willington, Bedfordshire, and the formation river-gravel.

J. T. Banton.

Kingston Rectory, Cambridge.
January 18, 1913.

P.S.—The Rev. O. Fisher M.A., F.G.S., and Professor J. E. Marr, Sc.D., F.R.S., who have seen the beads, both support the view of their having been used as personal ornaments. They are often, though by no means always, perforated naturally. There is strong reason for supposing they have been used as beads.—J. T. B.

Note by the Editor on the so-called 'Fossil Beads'.

In reply to Mr. J. T. Banton's letter it may interest some of our readers to learn that the so-called fossil beads were figured by Dr. G. A. Mantell in his *Geology of Sussex* in 1822 from the Chalk near Brighton; and in 1829 by Professor J. Phillips in *Geology of Yorkshire*. In 1833 Samuel Woodward in his *Outlines of the Geology of Norfolk* figured several examples from Norwich and from Holt as *Millepora globularis* (now known as *Porosphæra globularis*, Phillips, sp., a small globular species of Calcisponge from the Chalk of England and the Continent). Their history is very extensive, and has been most carefully set forth by Dr. G. J. Hinde, F.R.S. (see Journ. Roy. Micro. Soc., 1904, pt. i, pp. 1–25, pls. i and ii), who describes and figures six species.

In Mr. James Wyatt's paper in the *Geologist* (vol. v, pp. 233–5, 1862) the writer says he first became acquainted with these objects about fifteen years earlier (1847) when uncovering some Anglo-Saxon remains in the Kempston gravel-pit, near Bedford, when several round stones perforated were met with; he adds, "so strongly was I impressed at the time that they were the personal ornaments of the ancient chieftain just exhumed that I actually presented them to the Archæological Society as Saxon beads . . . Subsequent examination of the Drift gravels convinced me that the balls were of an earlier period than the Anglo-Saxon, whether works of art or natural productions. They are described by naturalists as specimens of the Chalk fossil *Coscinopora globularis*, but the question is, how did they become perforated?" Mr. Wyatt, after having examined a great number of specimens, concludes the perforation in these small globular bodies to be *artificial*. In this opinion he was supported by Dr. Rigollot,[1] who wrote that "les petites boules avaient servi à former des colliers à l'usage des peuple sauvages"; but subsequently a strong objection was taken to this opinion by M. Albert Gaudry, who[2] denies that there is any evidence for the assertion that these are works of art, and asserts that they are found *in the Chalk* perforated in the same manner as those specimens found in the Drift.

[1] See account of Dr. Rigollot's observations (*Mémoire sur les instruments en silex*, etc., p. 16, Amiens, 1854). See also Lyell's *Antiquity of Man*, 4th ed., 1873, pp. 165–6, fig. 22.

[2] Trans. Inst. France.

In the same volume of the *Geologist* (pp. 235–6) Professor T. Rupert Jones points out that these bodies, so common in the gravel of Chalk districts, particularly in Bedfordshire and at St. Acheul, have all been, originally, derived from the Chalk in which they are *abundantly found*, either perforated or solid, or with a more or less shallow hole in their substance. They occur in the Chalk itself; on the beaches under Chalk cliffs (as at Ramsgate, etc.) and in drift beds, the materials of which have been furnished by the Chalk, and in the decomposed chalk along the bottom slopes of the North and South Downs.

"The concavity of the typical variety (*Porosphæra globularis*) becomes in many of the globular forms a small cavity, a hole, or even a neat cylindrical perforation. The roundness of the specimens and their holes and tubular cavities," says Professor Rupert Jones, "appear to have suggested to the old Flint-folk of the Valley of the Somme, that they might be used for beads; such perforated forms are frequent in the gravel that yields the flint axes. I may add" (he says) "that the imperforate forms occur in the gravels just as

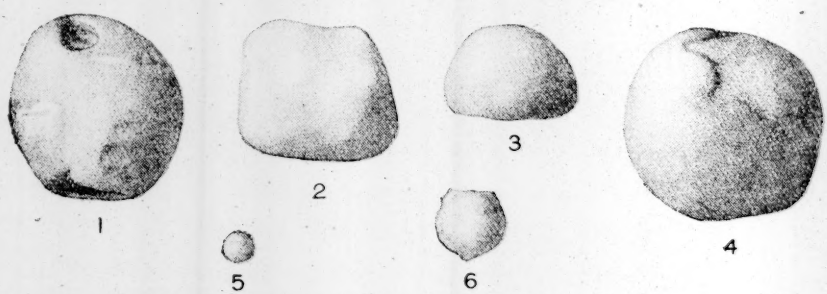

FIG. 1. *Porosphæra globularis*, Phillips, reproduced by the author's kind permission from pl. i of paper by Dr. G. J. Hinde, F.R.S. (Journ. Roy. Micro. Soc., 1904, p. 1–25).

much as the perforate. Also that the perforation of the non-drifted specimens in the Chalk is often just as smooth and straight as if artificial; the interior surface is *not worn*, however, but consists of the natural structure of the organism." (April 22, 1862.)

Dr. G. J. Hinde, F.R.S., in his valuable memoir on *Porosphæra* (Journ. Roy. Micro. Soc., 1904, pp. 1–25, pls. i and ii) says that Dr. A. W. Rowe, F.G.S., in his researches on the fossils from the different zones of the Chalk on the east and south coasts of England has met with many hundred examples of *Porosphæra* which he had placed in Dr. Hinde's hands for examination. This little sponge is common in the chalk cliffs of Yorkshire, Kent, Sussex, Isle of Wight, Dorset, and South Devon.

Dr. Hinde writes: "I may mention that within the limits of a moderately-sized garden situated on the slope of a chalk down at Croydon, Surrey, I have during the last sixteen years picked from the surface-soil 632 specimens of different forms of *Porosphæra* which have all been derived by slow weathering from the underlying Chalk."

Out of the large series of 2,902 specimens of *Porosphæra* examined and determined by Dr. Hinde, about two-thirds, he says, were obtained by Dr. A. W. Rowe, F.G.S., whose researches on the fossils of the different zones of the Chalk of England have become a classical work to all students of Cretaceous geology. In Dr. Hinde's opinion we find only 3 examples named *Porosphæra Woodwardi*, Carter, sp., from the Lower Chalk (Cenomanien) of Dover and the Dorset coast. 109 were obtained from localities in the Middle Chalk (Turonian), 99 of which are referred to *P. globularis*, 3 to *P. patelliformis*, and 7 to *P. arrecta*. But the majority of specimens, 2,770, were obtained from the Upper Chalk (Senonian), which yielded 2,244 examples of *P. globularis*, 257 of *P. nuciformis*, 149 referred to *P. pileolus*, 94 to *P. patelliformis*, 7 to *P. arrecta*, and 19 to "irregular forms of *Porosphæra*"; while of zones unknown, 14 are referred by Dr. Hinde to *P. globularis*, 1 to *P. pileolus*, 4 to *P. patelliformis*, and 1 an irregular form. In all, 2,902 were examined and determined by him, of which 2,357 are referred to *P. globularis* and 545 to the six other species. If we except the Lower Chalk, *P. globularis* occurs throughout the Middle and Upper Chalk, and is very abundant at Dover; in Devon, Seaford and Newhaven, Croydon, Margate, Brighton, Sewerby, and on the Dorset coast. These localities do

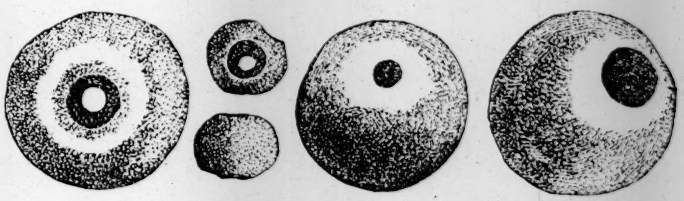

FIG. 2. *Porosphæra globularis*, Phillips, a small bead-like fossil sponge, derived from the Chalk, and found abundantly in the old river-valley gravels of Bedfordshire. The above figures are reproduced from an article by Mr. James Wyatt, F.G.S. (see the *Geologist*, vol. v., pp. 233–5, 1862).

not include the vast number met with in the Bedfordshire gravels and elsewhere *derived* from the Chalk, whilst it is abundant in the gravels at Amiens and Abbeville in France, and is present almost everywhere in the Chalk of Middle and Northern Europe. Dr. Hinde adds: "In form these sponges are generally rounded like peas or marbles, but are sometimes oval, loaf- or cushion-shaped, without any distinctive base; they are mostly free and unattached, but in many cases they grew round foreign bodies, which have been incapable of fossilisation, and these sponges now exhibit cylindrical hollow tubes which extend partly or entirely through them [see 1, Fig. 1]. Generally increase of growth is uniform over the surface, but in some instances fresh layers are formed so as only to cover portions of the surface at once [see 4, Fig. 1]. Small specimens are found of about 1 mm., the larger forms range to 34 mm. in diameter." (Op. cit., p. 19.)

In another place (p. 11) Dr. Hinde says: "Numerous specimens of *P. globularis*, and also of *P. nuciformis*, are penetrated by cylindrical

tubes, some of which extend quite through, so that the specimen becomes a natural bead, whilst others reach only to the central portion of the fossil or beyond to near the opposite side, but without passing through it completely [see 1, Fig. 1]. The tubes generally pass straight through the centres of the rounded forms, but they are not definitely orientated in the cushion- or pear-shaped fossils through which they extend either longitudinally, transversely or obliquely. Out of 1799 specimens of *P. globularis* . . . 321 or about 18 per cent were perforated; 147 being completely perforated, or natural beads, whilst 174 were partially perforated. Of *P. nuciformis* there were tubes in 32, 6 of which extended through, whilst 26 only reached to varying depths in the fossils."

In a letter just received from Dr. Hinde, the writer says: "I do not doubt in the least that the perforations are *natural* and I think it is a mistake to suppose that they have been artificially produced. Numbers of specimens from the surface soil of my garden still have the holes solidly infilled with chalk and I have had to pick out the material with a needle, so that in these examples, at least, the holes were present when the fossil was imbedded in the chalk ooze of the sea-bottom."

He adds: "Mr. G. Crick gave me, some years ago, numerous specimens of *P. globularis* from the Bedfordshire gravels, in which they are so common as to serve as playthings for children! These gravel-specimens have their holes wider and larger as a rule than those obtained direct from the Chalk"—having been *waterworn*. "I quite agree with you that there is no definite evidence that they were used as beads by prehistoric man, although they might have been so used."

Referring to the abundance, origin, and wide distribution of this little sponge in the river-valley gravels of the Ouse, Mr. Horace B. Woodward, F.R.S., writes me: "The *Porosphæra* may well have come from the Chalk of Bedfordshire, which rises up in the Dunstable and Luton Downs—a continuation of the Chiltern Hills. It may also quite possibly have come indirectly by way of the 'Chalky Boulder-clay', which covers large tracts of the Bedford Vale resting on Oxford Clay, bordering the Valley Gravels. The gravel is largely made up of chalk-flints, but it also contains a good deal of Oolitic limestone, derived from the Great Oolite, etc., or from the Boulder-clay."

From the foregoing observations I think we may conclude—

1. That the cylindrical perforations, so commonly present in specimens of *Porosphæra, are natural, not artificial*, being met with as frequently in specimens obtained directly from the Chalk as in those met with in the Valley Gravel.

2. That their great abundance, scattered promiscuously through the gravel of Bedfordshire and elsewhere, affords no evidence in favour of their having been adopted as ornaments by prehistoric man.

3. That there is no case known or recorded in which they have been so used.

On the other hand, the shells of *Nassa neritea* and teeth of stag bored for suspension probably as a head-dress or necklace were found

with the skeleton of a prehistoric man, probably of Neolithic age, in a cave at Mentone.[1]

There are some interesting notes by Dr. Robert Brown, F.L.S., F.R.G.S. (1868), and Mr. Alexander C. Anderson (Vancouver Island) on shells used by prehistoric people and modern North American Indians as ornaments (see *Reliquiæ Aquitanicæ*, by E. Lartet and H. Christy, edited by T. Rupert Jones, 1865–75, p. 296). In the same work also at p. 70 a shell-necklace from Cro-Magnon Cave is figured on B, pl. xi, composed of *Littorina littorea*, *Purpura lapillus*, *Turritella communis*, etc.

In the Cavern of Bruniquel explored by the Vicomte de Lastic in the Valley of the Aveyron *fossil shells* were found *perforated*, which had evidently been used as personal ornaments (see op. cit., p. 70); the collection is now preserved in the British Museum.

H. W.

SEA-WATER AND CRITICAL TEMPERATURES.

Sir,—How very true the parable of the moat and the beam is, and what a good example thereof is afforded by the letter of Mr. A. R. Hunt in your last number! He accuses his fellow-workers in geology, after a disquisition on the knowledge of foreign languages, of neglecting the researches of Daubrée and other workers abroad. Yet, although he has written on the subject of sea-water in volcanic and metamorphic action, he has apparently never read some dozen or more papers of mine on that subject, written years before (1892–4), though his own countryman.

I have distinctly shown that the critical point of water has nothing whatever to do with the question, and that we have to consider the physical conditions of the gas H_2O *in solution*, under varying pressure in fused silicates and oxides. I have urged the alkalinization of magmas by the assimilation of the alkaline salts in sea and other water, and accompanied by the liberation of the acid radicles in the form of the enormous emanations at volcanic vents. Furthermore, as mineralizers and fluxes, I have mentioned over and over again saline substances as being great agents in metamorphism. I laid down the fundamental principles of eruptive activity, which have never been controverted or controvertible because they are demonstrated and illustrated in all volcanic regions, principally by the nature and characters of the fragmentary ejecta of volcanoes.

Strangely enough, geologists and petrographers steadily and uniformly ignore the invaluable lessons taught by a study of fragmentary ejecta, while they cover thousands of pages with hypothetical, chemical groupings of massive rocks, ornamented by the most astoundingly complicated nomenclature, which, in the end, adds naught to our knowledge. Almost equally uselessly, they make elaborate calculations of percentages of different hypothetical felspars, and are blind to other structures that really record the vicissitudes between the primitive, purely vitreous paste and the consolidated rock.

[1] See *Comptes Rendus*, No. 26, p. 1597, June, 1872; also Geol. Mag., Vol. IX, pp. 272–4, 1872 (with a figure); also op. cit., p. 368, and article by Professor John Morris, *Pop. Sci. Review*, July, 1872.